ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXX. No. 24.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.......... 465

Comparative Tests to Determine Practicability of Testing Cement by Flexure (*illustrated*) 466
Passenger Cars: New York Central R. R. (*illustrated*).......... 470
New York & Brooklyn Bridge in 1893.......... 471
Sewage Purification in America (continued).......... 477
Rules for the Use of Belting (continued) 477
Traction Engines at the World's Columbian Exposition 479
Canal St. Folding Bridge, Chicago, Ill. (*illustrated*), 480
The Machine Tool Exhibit at the Columbian Exposition.......... 480

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS.......... 471

EDITORIAL NOTES.......... 474

Conditions of Thesis Competition, 1894 — Packing Cotton for Export—Rules for Proportioning Belting.

EDITORIAL.......... 475

Testing Cement by Flexure.

LETTERS TO THE EDITOR.......... 475

Experiments on the Mechanics of Flight—"American" Engineering Schools—Transition Curves—The Philadelphia Moon Schedule—Ontario Pumping Engine, Personal — The Am. Soc. C. E. Election: A Card from Mr. Francis Collingwood.

CONSTRUCTION NEWS.......... 481

Railways, Street Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.

INDUSTRIAL NOTES.......... 84

Postmaster-General Bissell, in his first annual report on the working of his department, favors the utilization of local electric car lines for mail transportation. He includes both rapid transit city and suburban lines in this recommendation. Mail is already thus handled on many suburban lines to the great advantage of residents.

The stay of the injunction against the New York Air-Brake Co., asked for by its counsel, as reported in our issue of Nov. 30, has been refused by Judge Townsend. He says in his opinion after summarizing the arguments presented by the opposing counsel:

> To permit the defendants to sell the infringing equipments at a fixed rate for each apparatus would be to prevert the decision of the court from an injunction into a license. It would deprive the patentee of the monopoly granted him under the law of the United States and establish an infringing rival in a competing business. Furthermore, as it is impossible, in this case, to estimate the damages and profits from the infringement, an injunction is complainants' only available remedy.
>
> The motion of defendants is, in effect, that they may be permitted to make a profit of about $100,000 out of apparatus manufactured with full notice of complainants' rights, and during the pendency of the suits in which they are now enjoined.
>
> From the statements contained in a circular letter sent out by defendants immediately after the filing of the opinion, and produced at the hearing on these motions it would appear that the denial of the motions cannot operate harshly upon the defendants. In said circular they stated that "so far as the freight triple valve is concerned the decision is unimportant, for no principle is involved, and only trifling and unimportant changes are necessary to make our triple valve free, in view of the very narrow construction given to the Westinghouse patents by the court."
>
> If this statement does not apply to the equipments on hand, they need only be held subject to the final decision of the appellate court. But the defendants cannot complain if they are merely subjected to the necessity of making trifling and unimportant changes in such apparatus as they may manufacture during the intervening period.

The Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., has completed plans for its new works at Brinton, Pa., where it has acquired 23 acres of land, and will shortly let contracts for construction, work to be commenced in the spring. There will be nine buildings, of brick and steel, located on a plot of ground 400 × 2,400 ft. These buildings will be an office, a machine shop, a warehouse, a power house, a punch department, a foundry, a blacksmith shop, a carpenter shop and a tin and paint shop. Contracts for the machine shop and the warehouse will be let Dec. 16 by the East Pittsburg Improvement Co. The machine shop will be 754 × 231½ ft. and will cover four acres. The warehouse will be 754 × 76 ft. To handle the goods in these buildings there will be two 30-ton traveling cranes, eight ten-ton and two two-ton cranes. The six skylights in the roof will be 20 × 175 ft. Special attention has been given to the arranging of the storeroom and warehouse for the carrying of supplies and manufactured material in such a manner that the least possible amount of material will be required with the minimum cost of handling, and the tools have also been arranged with reference to economy in handling the material. The central part of the machine shop will contain powerful electric cranes, capable of handling the largest pieces of machinery.

The Interstate Commerce Commissioners' seventh annual report has been given to the press in abstract. The report opens with a general review of the relations between the railways and the public and the Commission's work in protecting the public from extortion and discrimination. The spirit is expressed by the following extract: "Transportation is a constant and universal necessity, and the state is bound to see that the terms upon which it is furnished are not burdensome or unequal." The policy of the Commission has been to make proceedings before it as simple as possible. There is comparatively little and often no expense to complainants in proceedings before the Commission. The investigation of informal complaints in the form of letters from aggrieved shippers forms a large part of the Commission's work.

The Commission combats the common charge that the pecuniary embarrassments of the railways are due to the operation of the interstate law, and protests that it is unfair to lay upon the Commission the evils which result from mistaken policies of rate making or management. The Commission asks, however, that authority should be given it to fix minimum as well as maximum rates, where occasion requires. The subject of uniform classification is again brought up, and in view of the abandonment of the attempt by the railways to devise a system of uniform classification, legislation is asked compelling the railways to devise and adopt such a system within a year or else have the Commission undertake the task. The evils of freight car ownership by private companies are discussed at length, and it is stated that over $30,000,000 per annum is now paid by the railways as mileage on private freight cars.

The new filter beds of the water-works of Lawrence, Mass. (Eng. News, Aug. 3, 1893), are giving good satisfaction, according to an official letter of Mr. Hiram F. Mills, Chairman of the Committee on Water Supply of the State Board of Health, addressed to Mr. A. McCormick, President of the Lawrence Water Board. Mr. Mills states that since Sept. 20, when the beds were put in operation, the filters have removed 98% of all the bacteria in the applied river water and have converted a large part of the organic matter in the water to harmless mineral matter, thus depriving the few remaining bacteria of food. This deprivation of food, coupled with the decrease in numbers caused by the passage through the reservoir and distributing system, results in a further reduction of 1½% in the number of bacteria, leaving but ½% in the water delivered to consumers. These few bacteria are of a hardy and harmless variety. In October and November, 1892, the deaths from typhoid fever in Lawrence were five for each month, while this year they were only one per month.

There have been few serious accidents reported during the past week, the most serious one having been a head collision of freight trains on the Great Northern Ry., near Ellwall, Wash., in which three trainmen were killed. The wreck caught fire and two of the men were burned to death.

A locomotive boiler explosion occurred on the Fitchburg R. R. at Baldswinsville, Mass., Dec. 7. A doubleheader freight train had stopped at the water tank, and while the first engine was taking water the boiler of the second exploded. According to press reports the crown sheet collapsed owing to low water in the boiler. Two men were injured.

A fire at the navy yard at Norfolk, Va., Dec. 6, destroyed a storehouse filled with all the steam engineering stores of the yard and some small machinery. The building was 275 ft. long and three stories high. The loss is estimated at $150,000 to $200,000.

The reorganization committee of the Nicaragua Canal Company, made up of Messrs. John R. Bartlett, Smith M. Weed, H. E. Howland, R. L. Edwards, John L. Emery, W. Mynderse and E. K. Sibley, report as follows: The books of the old company show an investment in actual cash of $4,451,568.64, and the putting out of securities amounting to $2,923,200, which has been used in the purchase of the plant used in digging the canal. This money has been spent as follows: Concessions from Nicaragua and Costa Rica, and a charter from the United States, survey and location of the canal route, construction of 1,000 ft. of breakwater at San Juan del Norte, building of warehouses, piers, hospitals, workshops, etc., at San Juan del Norte; purchase of an extensive dredging plant, purchase of an exclusive right to navigate the San Juan River and Lake Nicaragua, the excavation of 2 miles of canal, the construction of 11 miles of railroad and 60 miles of telegraph, and clearing a large number of miles of the line of the canal from timber. The plan of the reorganization is as follows: Each depositor of stock will receive for each 10 shares of his stock deposited one share of the stock of the new corporation; par value, $100. Each depositor of stock electing to pay $3.50 per share upon his stock deposited will receive for each two shares of his stock so deposited one share of the stock of the new corporation; par value, $100. The plan submitted provides for the creation of a new company with a capital stock of $12,000,000, of which $6,000,000 is to be retained for the benefit of the treasury and $6,000,000 is to be distributed to stockholders of the present company, in exchange for their old stock, or is to be sold for cash requirements and to protect and maintain the present plant and property of the company. The new company will own all of the assets of the present company. It will have in its treasury stock of the Maritime Canal Company amounting to $14,876,750 and obligations for first-mortgage bonds of the Maritime Canal Company amounting to $5,550,950. Of its own full-paid stock $6,000,000 will be in its treasury or will be held by trustees for the benefit of the company.

Electric interlocking plant has been installed at two double track grade crossings of the Chicago, Milwaukee & St. Paul Ry. and the Chicago North Shore Electric Ry. A section of the trolley on each approaching track is insulated from the rest of the line, and the feeders for these sections are led through the signal tower and connected with the interlocking mechanism. When the signals are clear and the gates up for the electric railway the circuit is closed to the trolley wire section, and a derailing switch is opened on each track of the steam railway. The switches are 400 ft. from the crossing and protected by a semaphore signal 1,800 ft. distant. Before closing the derailing switches the signal man must first open the trolley wire circuit, so that the cars cannot run, close the gates and raise a stop block on the electric railway track. The wire section cut out does not extend across the track, so that if the man should change the signal while a car was actually crossing, the car would be able to run off. The plan was proposed by Mr. George Gibbs, Mechanical Engineer of the C., M. & St. P. Ry., and the switch and signal plant was put in by the Union Switch & Signal Co., of Pittsburg, Pa.

The Massachusetts State Highway Commission is giving a series of public hearings, and many petitions for highways under the new system have been received from nearly all parts of the state. The commission says that there are about 20,000 miles of highways in Massachusetts, and that about 10% of these will sooner or later come under the provisions of the new law with a cost to the state of about $10,000,000. If each county will build from 10 to 15 miles of state road each year it will take from 10 to 15 years to complete the work in the 14 counties, and an appropriation of $500,000 each year is hoped for. Commissioner McClintock said that the cities would furnish about 68% of the money thus expended. The State Commission is now making a collection of road materials, including rock, gravel, sand and clays, so that eventually the commission can tell at once what class of material is available for road construction in any portion of the state.

A whaleback steamship line is to be operated by the George Detrick Steamship Company, between San Francisco and Puget Sound, for passengers and freight. The first steamer, now building at Everett, on Puget Sound, is to be 361 ft. long, 42 ft. beam and 26½ ft. depth of hold, with a net capacity of 5,000 tons. She is to have triple expansion engines and a speed of 16 knots per hour.

The Manchester Canal, which will be opened to public traffic on Jan. 1 next, and was officially opened on Dec. 7, is 35½ miles long, and was commenced in November, 1887, and finished this month at a total cost of nearly $80,000,000. The canal is 26 ft. deep and 120 ft. broad on the bottom, with a total rise of 60 ft. above sea level at Manchester. This rise is overcome by four sets of locks, arranged in sets of three, of which the largest is 500 ft. long and 80 ft. wide. Leaving out the tidal entrance locks, at Eastham, the rise at each lock and the distance from the entrance are as follows: Latchford, 21 miles, rise 16½ ft.; Irlam, 28 miles, 15 ft.; Barton, 30 miles, 15 ft.; Salford, 33½ miles, 15 ft. The Manchester docks are to have a water area of 114 acres; a quay area of 152 acres, and a total length of 5¼ miles.

The Third Avenue cable railway, in this city, was officially opened to traffic on Dec. 4 from 130th to 6th St. Only 10 of the new cars are in service, but the number will be increased daily until the horse cars are superceded, which, it is expected, will be about Jan. 1 next.

COMPARATIVE TESTS TO DETERMINE PRACTICABILITY OF TESTING CEMENT BY FLEXURE.

By Herman E. Abbott, Hanover, N. H., and Edwin J. Morrison, Henniker, N. H., Graduates in the Class of 1893, Thayer School of Civil Engineering, Dartmouth College.

(Awarded first prize in Engineering News' Thesis Competition of 1893. This paper will be republished with some correlated matter in a small manual entitled "Practical Cement Testing.")

The proper methods of testing cement have received much attention ever since civil engineering became a distinct profession. The importance of the subject is evident from the fact that each year a larger per cent. of the cement used is subjected to various tests, while its character constantly improves. As is well known, thousands of tests have been made which have little value, simply because some of the conditions under which they were made were unrecorded. For many years each engineer had his own pet method of testing the cement used on work under his charge. As a result of this it was very difficult to compare tests, and contradictory results were often reached. The American Society of Civil Engineers took a long step in advance when it appointed a committee of experts to report on a standard and uniform method of testing cement.

One of the requirements of a standard method is that it may be used where expensive and bulky apparatus would be out of the question; and where, as on railway work, a separate outfit would be required for each division of the road, or for each considerable structure. No doubt manufacturers of cement are keenly alive to the fact that in the rush and hurry with which many of our engineering structures are built, testing the cement is entirely neglected, or, perhaps, a single test for free lime is made. Cases have occurred within the personal knowledge of the writers where a few tests would have saved some poor masonry and much trouble and expense for repairs. There is certainly need of a practicable method by which the hard-driven engineer in the field may make tests, as well as the inspector in his well-furnished laboratory.

The writers' belief that these requirements would be fulfilled by the method of transverse tests led them to take up this subject and make a fair investigation and comparison of the merits of the method with those of the method of tensile tests. Estimating the strength of a masonry structure as a whole, by the strengths of its component parts, is, as every one knows, largely guesswork. But it is certain that a sample of cement tested as a beam very nearly realizes the actual condition of things in a structure, where one side is under tension and the other side under compression.

Review of Former Experiments.—After a very extended search the writers have been unable to find any record of comparative tests of this kind, and so began their investigations with no precedents to bias their judgment. The idea of testing by flexure seems to have preceded that of utilizing tension. Indeed, it appears that formerly it was more frequently employed than the latter method. It may be of interest to make a brief resume of what has already been done in this line.

In a work published in 1835 by H. A. Soleirol, a French officer, are given the results of many thousands of tests, mostly transverse. These tests were made from 1819 to 1829, inclusive. Some of these tests were made on two pieces of stone cemented together and broken as a cantilever. A few were made by pulling the blocks apart by direct tension, and when the adhesion was sufficient this amounted to a tensile test. He also tried Vicat's method of penetration. From these tests Soleirol decided that the transverse test was the best, but as far as his tensile tests go, this seems unwarranted, for his apparatus for tensile tests was extremely crude and inaccurate.

In 1836 Colonel Pasley, of the Corps of Royal Engineers, made numerous experiments in this manner. He concluded that "the resistance of various stones in opposition to a breaking force is not in proportion to their specific gravity, nor in any direct proportion to their cohesiveness in opposition to a tearing force." He also stated that the absolute resistance of stones or mortars cannot be reduced to any just proportions founded on superficial measurements, and, further, that the small beams should have their resistance estimated like beams, "which no one has ever thought of reducing to the superficial centimeter or inch." From some experiments on the adhesive and cohesive strengths of mortars he came to the conclusion "that the strength of calcareous mortars should never be estimated by the superficial inch."

About 1829 Treussart made beams of mortar 6 × 3 × 3 ins., left them under water one year, and then scraped and ground the four sides until they were 2 ins. square. This was done with the idea of submitting to rupture only that portion which had not been in contact with water. Sometimes the mortars were harder at the surface than in the interior, and sometimes the reverse. His results are given in part by the actual breaking load, in part by the resistance per square centimeter calculated by the common theory of flexure.

Courtois, another French authority, used a mold 1.8 ins. long, 1.2 ins. square for neat cement, while for sand specimens a mold 4 × 1.8 × 1.8 ins. was adopted. The neat cement prisms were broken with a span of 1.2 ins., and those with sand with a span of 1.8 ins. He compared the strength of the two by the common formulas for flexure. Owing to faulty details of manipulation his results are of no value.

General Gillmore, who has, perhaps, paid more attention to the subject of cements and mortars than any other one man, made many transverse tests. His prisms were made in a vertical mold 2 ins. square and 8 ins. long, setting under a pressure of 32 lbs. per sq. in. These were broken with a 4-in. span. He reduced his results to the tensile strength per square inch by the common theory. Mr. D. J. Whittemore, himself an expert on the subject, expressed his opinion before the American Society of Civil Engineers, "that undue value is placed on experiments as heretofore conducted in ascertaining the tensile strength of cements to the exclusion of nearly all other tests. In my opinion one of the most satisfactory tests of the value of this material is that so largely employed by General Gillmore in accumulating data for his work on 'Limes and Hydraulic Cements,' to wit: That of subjecting specimens molded in the form of parallelopipedons to transverse tests." As it is understood that Mr. Whittemore once made a number of transverse tests, he probably had good foundation for this opinion.

In 1872 Edmund Yardley, in a paper before the American Society of Civil Engineers, gave an account of some transverse tests made by himself. His prisms were made in horizontal molds 1 in. square and 8 ins. long. Most of his specimens were immersed in water for 30 days and then broken with a 6-in. span. The specimens when tested were so placed that the exposed surface of the prisms as molded, was vertical. The two pieces were again immersed and tested with a 3-in. span, at ages varying from 30 days to 6 months. Some of his conclusions are doubtful, owing to the small number of specimens tested.

In the 13th edition of "Trautwine's Pocket-Book" is a short table in which are given the average ultimate tensile, compressive and transverse strengths of neat Portland and Rosendale cements. His transverse tests were made with prisms 12 ins. long and 1 in. square. He does not give the records of any parallel tensile tests. He says: "The London board of works require that Portland, after seven days in water, shall have at least 35 lbs. transverse and 350 lbs. tensile strength." He fails to give the span at which the beams are to be broken, but it is presumably 12 ins.

Mr. E. C. Clarke, while in charge of the Boston Main Drainage Works, made a few transverse tests of concrete, and computed the tensile strength by the "common theory." Records of a few other tests have also been found, but in each case the tensile strength (when computed) was deduced from the breaking weight by the "common theory."

Testing Apparatus.—The machine shown in detail in Fig. 1 was constructed by the writers for the sole purpose of making transverse tests, and is of the single-lever type, having the ratio of its lever arms 10 to 1. The lever arm is suspended as shown in Fig. 1, and the arrangement of the hook and thumb screw for drawing up on the staples, shown in the end elevation, is simply to counteract the weight of lever, can and counterpoise and always insure a proper bearing of the knife-edge against the iron plate on the lever arm.

The clip is shown in position in Fig. 1 and in detail in Fig. 2. The breaking bar "e" shown in section AB is attached to the knife-edge on the lever arm by a link connection, and works up and down on the line AB so as to be precisely centered for any span used. With this arrangement, by simply pressing the breaking bar against its upper seat, the prism can be quickly slid into its position on the supporting bars. Provision is made for using three spans, viz., 2½ ins., 4 ins. and 5 ins. A shift can be quickly made from one span to another by sliding the supporting bars into the proper holes. The round iron was used for bearings for the reason that it would not cut into the prisms as would a knife-edge, and when turned down to a perfectly cylindrical form as was done in this case, and the corresponding holes spaced accurately, the span must be accurate and invariable. It may be thought that the deflection of the prisms would change the span and also cause friction unless knife-edges were used for supports. This point was investigated, and the greatest deflection observed would change the span much less than .01 in., an unimportant amount for these experiments.

Fig. 3 shows the simple and by no means original arrangement for applying the weight. It consists of a tin can, into which water is run from a conveniently placed tank. The long tube, entered through the tunnel at the top, is for the purpose of letting the water gradually descend to the bottom with a whirling motion and without shock. The water coming from the tank runs through a thin rubber tube placed under the lever arm, so as to be automatically shut off the instant the specimen breaks. The glass tube shown on the outside of the can is connected through the bottom with the interior. A wooden scale is placed behind this tube and so graduated that the breaking weight is read off directly in pounds.

The molds in which the prisms were made were of two forms, viz., those filled at the end, which are denominated vertical molds, and those filled at the side, called horizontal molds. The latter only were used as a means of comparing the density of the briquettes and prisms.

The form of vertical molds adopted is shown in Fig. 4. The sides were of well seasoned cherry thoroughly soaked in linseed oil before being used. The strips of sheet iron slide into saw cuts about ¼ in. deep and very carefully spaced so that the clear distance between them shall always be 1 in. No. 25 B. W. G. was found to be the most satisfactory thickness for these strips. The first molds were insufficiently ironed, and after a short period of use warped so that they had to be discarded. After this experience, molds were constructed and ironed, as shown in the cut, Fig. 4, which have given entire satisfaction. For constant use these wooden molds would undoubtedly be short-lived, but have the great advantage of being very cheap. In Fig. 5 is shown a design for cast iron molds, which would be much more expensive than those above described, but if long and continuous use is to be made of them, they would probably give better satisfaction. The vertical molds were filled by putting in about a cubic inch of cement at a time and then lightly tamping it with a tamp about ⅜ in. square. A much larger tamp is liable to cause air holes in the specimens. Vertical molds were made for prisms 1¼ ins. square, and in form were in all respects like those described above except in the size of the section.

The horizontal molds were like the vertical molds in material and general construction, except that the strips of sheet iron were held in place in saw cuts in the sides and bottom of a shallow box 1 in. deep and 6 ins. wide. Fig. 6 shows the horizontal, vertical and briquette molds, with the Fairbanks testing machine.

Cements Used.—The cement used in the experiments about to be described was of five brands, viz.: Hoffman and Newark Rosendale, and Saylor's, Alsen's and Akron Portland. The Akron alone showed traces of free lime. The Saylor's was about two years old. The others were received direct from the manufacturers and were presumably fresh cements.

The sand used was sharp, siliceous and of such fineness that it all passed a sieve of 400 meshes per sq. in. (No. 28 wire), and was caught on a sieve of 900 meshes per sq. in. (No. 31 wire); this being the degree of fineness recommended by the American Society of Civil Engineers. The cement and sand were always very thoroughly mixed dry and then sufficient water was added to make a stiff paste. The mean temperature of the mixing water was about 60° F. and never varied more than 5° from the mean. The temperature of the room varied from 50° to 70°, but when the mixing was done was always about 65°.

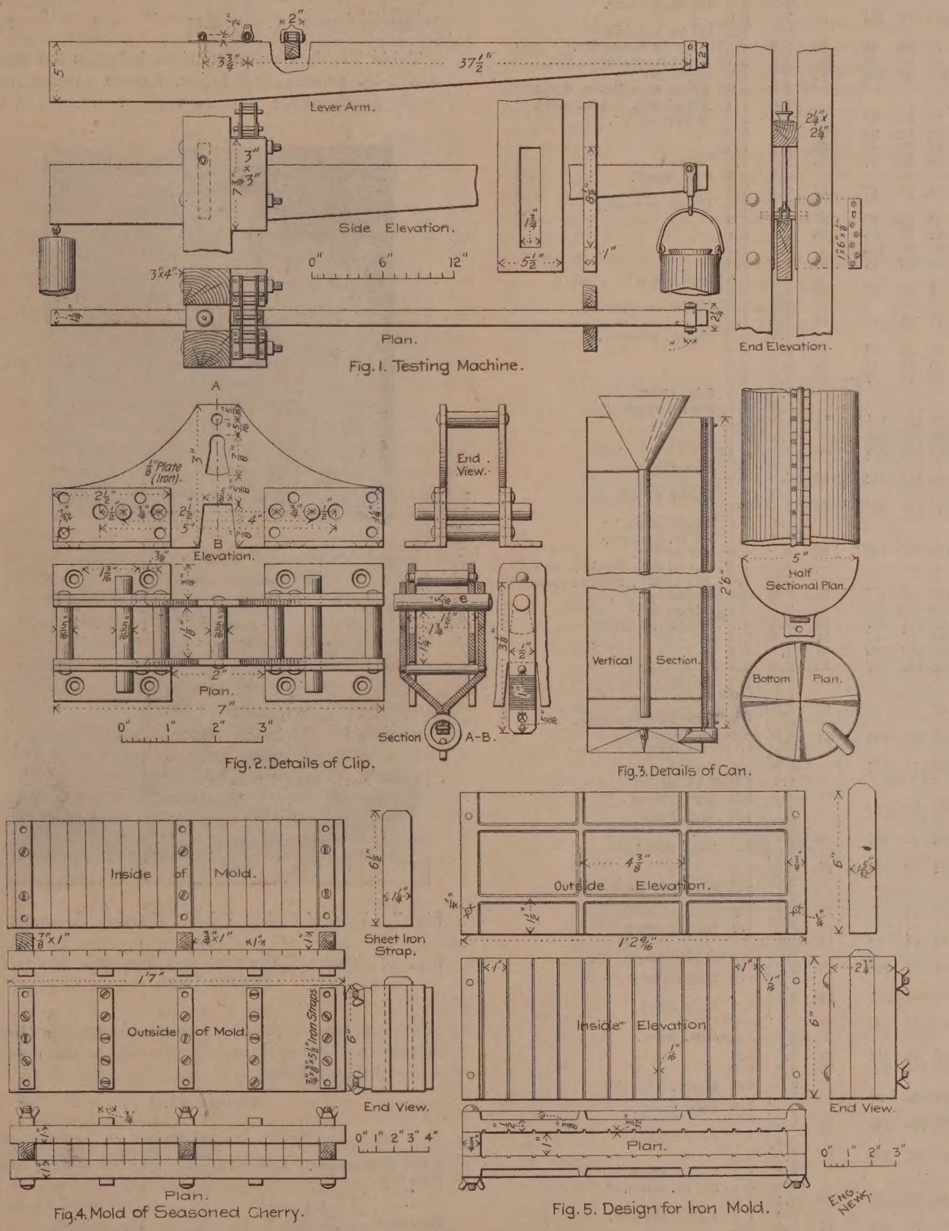


Fig. 1. Testing Machine.

Fig. 2. Details of Clip.

Fig. 3. Details of Can.

Fig. 4. Mold of Seasoned Cherry.

Fig. 5. Design for Iron Mold.

FIGS. 1-5. DETAILS OF TESTING MACHINE, MOLDS, CLIP, ETC., FOR TESTING CEMENT BY TRANSVERSE BREAKING.

Method of Making Tests and the Results Obtained.—A complete series of parallel tests was carried on using the standard (Am. Soc. C. E.) briquettes, and prisms 1 in. square. The 1-in. square section was adopted because it was the only one that would give a direct comparison with the standard briquettes. The prisms, 1 in. square and 6 ins. long, used but little more cement than the standard briquettes. It is to be especially noted that the briquettes and prisms were made from the same batch of cement and every precaution was taken to secure absolutely the same conditions for both the prisms and briquettes in a set.

The great majority of all transverse tests were made on a 4-in. span. The clip shown in Fig. 2 was not devised until some time after these investigations began. The first device for testing prisms was to support them on round iron bars of the same dimensions as those used in the clip and break them by the breaking bar, which, however, had to be centered every time by an auxiliary template—a process which took considerable time. The 1¼-in. square prisms were broken in this way.

The tensile tests were made partly on a Fairbanks testing machine, a photograph of which is shown in Fig. 6, and partly on a machine constructed here, and used for several years at this institution with very satisfactory results. Comparative tests on these two machines gave practically the same results.

Table I. is compiled from the record of 1,155 tests, of which number 455 were tensile tests and 700 transverse tests. The table explains itself except, perhaps, the last two columns. The column headed $\frac{R}{W}$ is simply a ratio. R = the tensile strength of the briquettes, and W = the breaking weight of the corresponding prisms. The column headed coefficient "C" represents the actual strength of prisms tested transversely, divided by the theoretical strength which they would have, calculated by the common formula: $\frac{1}{4}\ Wl = 1\text{-}6\ Rbd^2$, from the average tensile strength of the briquettes in the same set. A part of these specimens, selected at random, and so arranged as to show the fractured surfaces, is shown by the photographic view, Fig. 7.

Table II. gives the record of a series of experiments made to determine the difference, if any, in the ultimate strength of prisms made in vertical molds and those made in horizontal molds. This same series was made to determine another very important point, viz.: As to the relative densities of the prisms and briquettes. The one who filled the briquette molds also filled the horizontal molds and gave the cement in each case as nearly as possible the same pressure; while the other filled the vertical molds, giving them the usual tamping. In testing, these side-filled prisms were so placed on the supports that what had been the top surface, exposed to air in the molds, came on the side.

In Table II. and following tables the coefficient "C" is given instead of the actual breaking weight W. And the value of "C" for each set is given weight according to the number of prisms tested. The difference of 0.08 between the mean values of "C" is an amount which must be considered unimportant, for a material which breaks with such irregularity as cement. From the above results it appears that the vertical and horizontal prisms were of like strength and density, and therefore the prisms and briquettes were of like densities and the comparison allowable.

TABLE II.

		Vert.		Horiz.	
Kind of mixture.	Age.	No. tested.	Coeff. "C."	No. tested.	Coeff. "C."
Alsen 1-1	1	7	1.8	7	2.2
" "	7	9	1.9	7	1.9
" 2-1	1	10	1.6	7	2.0
" "	7	10	2.0	7	2.0
Akron neat	1	9	1.7	7	1.5
" "	7	9	1.8	7	2 1
" 1-1	1	9	1.5	7	1.7
" "	7	8	1.8	7	1.6
" 2-1	1	9	1.6	5	1.6
" "	7	9	1.5	5	1.8
Total		89		66	
Weighted mean			1.76		1 84

Table III. gives the record of a series of tests made to determine whether the coefficient "C" was independent of the span or varied with it. These tests were made upon prisms of the same set, part being tested at a 4-in. span and part at a 5-in. span. Quite an extended series of tests was made to determine whether one transverse break weakened the prism for a second test on a shorter or the same span. Table IV. gives the record of these tests. The columns headed 4-in. and 2½-in. spans* give values of "C" for first breaks. The column headed 2½-in. span** gives values of "C" for prisms which had been previously broken at a 2½-in. or 4-in. span.

TABLE III.

			Span			
			4 ins.		5 ins.	
Kind of mixture.		Age.	No. tested.	Coeff. "C."	No. tested.	Coeff. "C."
Newark	Neat	60	5	1.9	4	2.1
"	1-1	60	5	1.9	5	1.6
Hoffman	Neat	60	6	1.5	6	1.3
"	1-1	60	4	2.1	3	2.0
Alsen	Neat	60	4	2.4	5	1.9
"	1-1	60	6	2.0	3	1.9
Akron	Neat	60	4	2.1	4	2.0
Total			34		30	
Weighted mean				1.95		1.80

TABLE IV.

			Span.					
			4 ins.		2½ ins.		2½ ins.**	
Kind of mixture.		Age.	No. tstd.	Coeff. "C."	No. tstd.	Coeff. "C."	No. tstd.	Coeff. "C."
Newark	Neat	7	3	1.9	3	1.9	3	1.5
Hoffman	1-1	60	1	2.1			9	2.1
Alsen	Neat	7	6	2.2			5	2.1
"	"	1	4	1.9	3	1.6	4	1.6
"	1-1	60	4	2.7	4	2.3	4	2.2
"	1-1	60	5	2.0			4	1.9
"	2-1	60	4	2.1	6	1.9	6	1.8
"	2-1	1	7	1.3			6	1.3
"	2-1	7	7	2.1			8	2.3
Akron	Neat	7	6	1.5			5	1.6
"	1-1	60	8	3.3	3	2.7	3	3.4
"	1-1	7	8	2.3			6	2.0
"	2-1	60	5	3.1	5	3.8	5	2.7
"	2-1	1	2	1.4	3	1.3	4	1.1
Saylor's	Neat	7	6	2.3			6	2.5
"	1-1	1	5	2.0			5	1.7
"	1-1	7	6	2.3			6	1.7
Total			90		27		89	
Weighted Mean				2.2		2.3		2.0

In Table V. are recorded the results of 86 tests upon 57 prisms. About half of each set was tested at a 4-in. span, the rest were broken at a 2½-in.

TABLE I.—SHOWING RESULTS OF COMPARATIVE TENSILE AND BENDING TESTS OF CEMENT.

Name of cement.	Proportions by weight. Cement.	Sand.	Water.	Age in days.	Prisms. No. tested.	Highest.	Lowest.	Average.	P. c. good breaks.	Briquettes. No. tested.	Highest.	Lowest.	Average.	P. c. good breaks.	R/W	Coeff. "C."	Remarks.
Newark.....	70.4	....	29.6	1	10	15	12	14	100	10	40	33	37	70	2.6	2.3	
				7	10	37	17	24	100	9	113	46	72	78	3.0	2.0	
				60	5	64	46	52	100	9	191	137	167	56	3.2	1.9	
					4	50	45	47	75						3.6	2.1	5 in. span.
	73.6	....	26.4	1	5	35	31	33	60	5	87	75	81	80	2.5	2.4	
					4	53	42	47	100						1.7	1.8	1¼-in. prisms.
				7	5	54	36	45	40	5	149	119	134	40	3.0	2.0	
					3	66	60	63	100						2.1	1.5	1¼-in. prisms.'
	73.5	....	26.5	1	3	19	16	17	100	6	73	56	64	83	3.8	1.6	Kept in air at 60°.
					2	14	13	14	100	6	47	35	40	100	2.9	2.1	Kept in water at 55°.
				7	3	36	28	32	100	5	119	92	103	60	3.2	1.9	Air at 60°.
					3	63	43	51	100						2.0	1.9	Air at 60°; 2½-in. span.*
					3	41	38	40	100						2.6	1.5	Air at 60°; 2½-in. span **
					5	23	16	20	100	5	86	59	69	80	3.4	1.8	Water at 55°.
	41.2	41.2	17.6	1	9	11	7.5	9.6	100	10	30	21	26	90	2.7	2.2	
				7	10	20	11	16	100	10	61	37	49	60	3.1	1.9	
				60	5	38	19	29	100	11	98	92	94	36	3.2	1.9	
					5	23	17	20	100						4.7	1.6	5-in. span.
	41.8	41.8	16.4	1	6	11	6.5	8	83	6	31	22	27	67	3.4	1.8	
					3	15	12	14	100						1.9	1.6	1¼-in. prisms.*
				7	7	23	11	16	86	4	59	59	59	25	3.7	1.6	
Hoffman. . .	76.2	....	23.8	1	10	27	14	20	100	8	64	50	58	88	2.9	2.1	
				7	9	35	25	30	100	8	127	99	116	50	3.9	1.5	
				60	6	85	53	67	100	8	299	232	272	62	4.1	1.5	
					6	57	31	45	100						6.0	1.3	5-in. span.*
	75.6	....	24.4	1	7	22	16	19	100	9	72	58	63	89	3.3	1.8	
					5	31	27	29	100						2.2	1.4	1¼-in. prisms.
				7	7	48	25	34	100	9	147	98	119	44	3.5	1.7	
					5	56	45	50	100						2.4	1.3	1¼-in. prisms.
	45.2	45.2	9.6	1	7	7	5	6	86	8	29	19	23	75	3.8	1.6	
				7	8	13	10	12	100	8	49	33	44	62	3.7	1.6	
				60	4	32	19	27	100	7	81	73	77	43	2.9	2.1	
					3	20	20	20	100						3.8	2.0	5-in. span.
					9	55	31	43	100						1.8	2.1	2½-in. span.**
Alsen's......	80.0	....	20.0	1	9	40	30	34	100	8	152	133	144	75	4.2	1.4	
				7	9	127	75	101	89	8	288	242	265	25	2.6	2.3	
				60	4	152	112	129	100	7	345	284	323	57	2.5	2.4	
					5	87	70	82	100						3.9	1.9	5-in. span.
	80.0	....	20.0	1	6	70	50	56	100	6	151	124	142	60	2.5	2.4	
					5	108	89	94	100						1.5	2.0	1¼-in. prisms.*
				7	7	166	91	124	86	6	335	326	330	33	2.7	2.2	
					5	240	143	183	100						1.8	2.1	2½-in. span.**
					4	190	165	180	100						1.8	1.7	1¼ in. prisms.*
	79.7	....	20.3	1	4	56	49	51	100	6	171	134	156	83	3.1	1.9	Air at 60°.
					3	71	62	67	100						2.3	1.6	Air at 60°; 2½-in. span.*
					4	70	65	68	100						2.3	1.6	Air at 60°; 2½-in. span **
					6	34	28	30	100	6	136	94	115	67	3.8	1.6	Water at 55°.
				7	6	121	85	105	100	6	320	220	276	50	2.6	2.3	Air at 60°.
					6	138	114	129	100	6	400	311	327	83	2.5	2.4	Water at 55°.
	42.9	42.9	14.2	1	8	16	9	11	100	7	47	47	47	14	4.3	1.4	
				7	8	81	52	70	100	7	225	216	220	86	3.1	1.9	
				60	5	130	90	103	80	8	268	191	227	62	2.2	2.7	
					4	172	122	146	100						1.6	2.3	2½-in. span.*
					4	196	106	138	100						1.7	2.2	2½-in. span.**
	42.9	42.9	14.2	1	9	16	12	13	78	7	56	52	54	43	4.2	1.6	Side-filled prisms.
					7	18	11	16	100						3.4		
Alsen's......	42.9	42.9	14.2	7	9	81	56	65	100	8	254	190	206	63	3.2	1.9	Side filled.
					7	75	53	64	100						3.2		
				60	6	123	75	106	83	7	352	272	316	71	3.0	2.0	
					3	92	67	79	100						4.0	1.9	5-in. span.
					4	195	127	156	100						2.0	1.9	2½-in. span.**
	29.5	59.0	11.5	1	10	11	7	9	100	8	38	29	33	50	3.7	1.8	Side filled.
					7	12	10	11	100						3.0		
				7	10	41	29	36	100	8	133	90	108	100	3.0	2.0	Side filled.
					7	41	30	36	100						3.0		
	29.5	59.0	11.5	60	4	64	48	54	100	8	214	92	156	88	2.9	2.1	
					6	105	55	79	100						2.0	1.9	2½-in. span.*
					6	86	49	74	100						2.1	1.8	2½-in. span.**
	29.5	59.0	11.5	1	7	9.5	5.5	7.3	100	5	33	33	33	20	4.5	1.3	
					6	13	10	11	100						3.0	1.3	2½-in. span.**
				7	7	44	27	33	100	4	95	95	95	25	2.9	2.1	
					8	84	31	60	100						1.6	2.3	2½-in. span.**
Akron......	75.4	....	24.6	1	10	39	25	32	90	8	141	97	115	75	3.6	1.6	Side filled.
					7	32	26	29	100						4.0		
				7	9	72	58	64	100	8	237	181	211	75	3.3	1.9	Side filled.
					7	85	59	72	100						2.9		
				60	4	115	98	107	100	8	400	185	300	75	2.8	2.1	
					4	89	78	83	100						3.7	2.0	5-in. span.
	75.4	....	24.6	1	6	36	29	33	100	5	126	98	113	80	3.4	1.8	
				7	6	65	52	61	100	4	258	214	239	75	3.9	1.5	
					5	108	94	102	100						2.3	1.6	2½-in. span.**
	42.3	42.3	15.4	1	10	33	19	24	90	8	104	90	98	75	4.1	1.6	Side filled.
					7	52	23	28	100						3.5		
				7	11	54	31	44	73	8	170	129	150	88	3.4	1.7	Side filled.
					7	46	28	40	100						3.8		
				60	8	107	52	77	100	8	181	92	138	88	1.8	3.3	
	42.3	42.3	15.4	60	3	136	86	108	100						1.4	2.7	2½-in. span.*
					3	128	120	125	100						1.1	3.4	2½-in. span.**
	42.3	42.3	15.4	1	7	26	6	14	85	6	64	53	57	50	4.1	1.5	
					5	24	19	22	80						2.6	1.2	1¼-in. prisms.
				7	8	65	24	45	100	6	156	93	119	67	2.6	2.3	
					6	108	46	64	100						1.9	2.0	2½-in. span.**
	28.9	57.8	13.3	1	10	11	5	8.2	90	8	34	28	31	57	3.8	1.6	Side filled.
					7	11	6	8.1	71						3.8		
				7	9	23	13	19	100	8	88	66	74	63	3.9	1.7	Side filled.
					7	27	16	22	71						3.4		
				60	5	47	18	32	100	7	70	55	60	86	1.9	3.1	
					5	71	56	63	100						1.0	3.8	2½ in. span.*
					5	52	33	43	100						1.4	2.7	2½-in. span.**
	28.8	57.6	13.6	1	2	10	9	9.5	100	7	47	36	40	86	4.2	1.4	
					3	15	11	14	100						2.9	1.3	2¼-in. span.*
					4	14	10	12	100						3.3	1.1	2½-in. span.**
				7	4	20	14	18	100	8	85	80	82	50	4.6	1.3	
Saylor's.	79.6	....	20.4	1	6	51	34	39	100	6	163	114	145	83	3.7	1.6	
				7	7	100	47	78	100	5	280	214	238	60	3.1	1.9	
	79.6	....	20.4	1	6	48	39	43	100	6	197	144	164	[illegible]	3.8	1.6	
					4	79	73	77	100						2.1	1.5	1¼-in. prisms.
	79.6	....	20.4	7	6	85	52	71	100	6	219	167	188	50	2.6	2.3	
					6	134	119	127	100						1.5	2.5	2½ in. span.**
					4	150	120	139	100						1.4	2.2	1¼-in. prisms.
	46.8	46.8	6.4	1	7	20	13	16	100	6	46	32	38	50	2.4	2.5	
				7	7	63	49	55	71	6	183	147	161	67	2.9	2.1	
	43.8	43.8	12.4	1	6	23	17	21	89	5	73	58	63	60	3.0	2.0	
					5	36	24	29	100						2.2	1.7	2½-in. span.**
				7	6	69	43	57	100	6	177	136	148	67	2.6	2.3	
					6	87	56	68	100						2.2	1.7	2½-in. span.**

* First breaks. ** Previously broken at 4-in. span.

span and the longer end then broken again at the same span. This afforded a direct comparison upon the same prisms of the values of "C" for first and second breaks.

TABLE V.

Kind of mixture.		Age.	Span 4 ins. No. tstd.	Coeff. "C."	2½ ins.* No. tstd.	Coeff. "C."	2½ ins.** No. tstd.	Coeff. "C."
Newark.	Neat	7	3	1.9	3	1.9	3	1.5
Alsen.....	Neat	1	4	1.9	3	1.6	4	1.6
"	2-1	60	4	2.1	6	1.9	6	1.8
"	1-1	60	4	2.7	4	2.3	4	2.2
Akron....	"	60	8	3.3	3	2.7	3	3.4
"	2-1	60	5	3.1	5	3.8	5	2.7
"	"	1	2	1.4	3	1.3	4	1.1
Total..............			30		27		29	
Weighted mean............				2.57		2.3		2.1

Table VI. shows a comparison between the standard 1-in. prisms and 1¼-in. square prisms, both made at the same time in vertical molds and out of the same batch of cement. Comparing these prisms in the usual manner the large ones show a decided weakness.

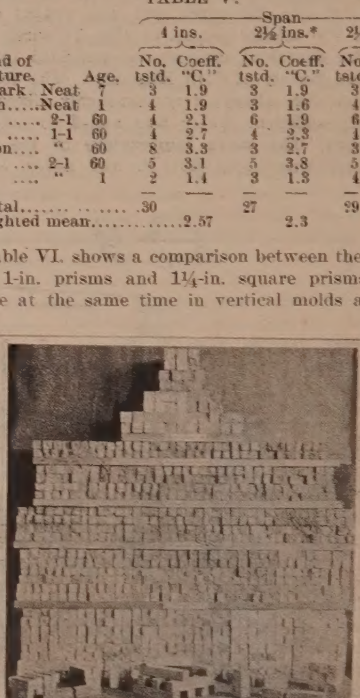


Fig.7.

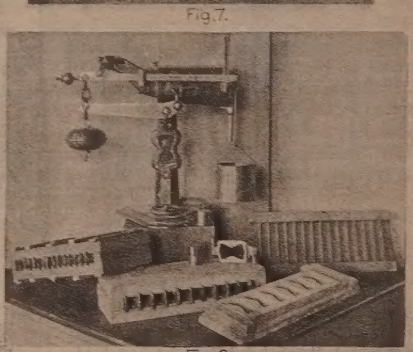


Fig.6.

Fig. 7. View of Broken Prisms Showing Evenness or Fracture.

Fig. 6. View of Machine and Briquette Molds for Tensile Tests.

TABLE VI.

Kind of mixture.		Age.	Area. 1 sq. in. No. tested.	Coeff. "C."	1¼ sq. in. No. tested.	Coeff. "C."
Newark ...	Neat	1	5	2.4	4	1.8
"	"	7	2	2.0	3	1.5
"	1-1	1	5	1.8	3	1.6
Hoffman.....	Neat	1	7	1.8	5	1.4
"	"	7	7	1.7	5	1.3
Akron.....	1-1	1	6	1.5	4	1.2
Alsen.........	Neat	1	6	2.4	5	2.0
"	"	7	5	2.2	4	1.7
Saylor's......	Neat	1	6	1.6	4	1.5
"	"	7	6	2.3	4	2.2
Total.............			55		41	
Weighted mean ..				1.95		1.62

Mr. D. J. Whittemore, in a paper before the American Society of Civil Engineers (see "Transactions," Vol. IX.), mentions the fact that briquettes of different cross-sections give different tensile strengths per unit area. From his own experiments, and from some by Mr. John Grant, M. Inst. C. E., he deduces the law, that the strength per unit area varies inversely as the peripheries of the cross-sections. The following table shows the averages from which he drew this conclusion.

Whittemore's Experiments.

No. Tests.	Area 2 sq. ins. Sq. ins.	Lin. ins.	Area ½ sq. in. Sq. ins.	Lin. ins.
Ros. 7....	55.7	22.3	110.8	22.1
Port. 7....	309.6	123.8	585.4	117.1

Grant's Experiments.

No. Tests.	Area 4 sq. ins. Sq. ins.	Area 4 sq. ins. Lin. ins.	Area 2¼ sq. ins. Sq. ins.	Area 2¼ sq. ins. Lin. ins.
Port. 7	330.0	151.5	418.5	156.9
Port. 30	343.8	171.9	443.7	166.4

Accepting the deductions of Mr. Whittemore as correct, the apparent weakness of the large prisms is accounted for. The experiments made by the writers would seem to confirm these deductions; for, upon computing the strength of the large prisms by Mr. Whittemore's method, it checks very closely with that of the 1-in. prisms.

Nearly all of the prisms and briquettes were kept in air, after being taken from the molds, but a series of tests was made to determine whether immersion in water would have any effect upon the coefficient "C." In Table VII. is the record of 79 tests.

TABLE VII.

Cement (neat).	Age.	Briquettes. No. tested.	In air.	No. tested.	In water.	Prisms. No. tested.	In air.	No. tested.	In water.	Coef. "C" Air.	Water.
Newark	1	6	64	6	40	3	17	2	14	1.6	2.1
"	7	5	103	5	69	3	32	3	21	1.9	1.8
Alsen...	1	6	156	6	115	4	51	6	30	1.9	1.6
" ...	7	6	276	6	327	6	105	6	129	2.3	2.4
Total..		23		23		16		17			
Mean..........										1.92	1.97

The above table shows that although immersion in water very materially affects the ultimate strength of both prisms and briquettes, the value of "C" remains practically constant.

Discussion of Results.—In making these tests the speed of applying the breaking weight varied slightly, but a sufficient series of experiments was made to entirely satisfy the writers that within the range of speed used it made no practical difference in the ultimate strengths obtained.

Table III. shows that prisms tested at a 5-in. span gave smaller values of "C" by about 8% than those at a 4-in. span. This would seem to indicate that "C" varies inversely with the span. On the contrary, Table V., based upon about the same number of tests, indicates that "C" varies directly with the span. It is believed that these variations of 8% and 10% in opposite directions cannot be regarded as important, while any one who has ever tested cement will admit that any very slight causes produce differences much greater than these. In the "Engineering Record" (Vol. 27, p. 174) is an article showing the discrepancies in cement tests, due to the filling of the molds by different individuals. These variations are in some cases as high as 60%. In "Trans. Am. Soc. C. E.," Vol. 25, p. 299, is given a table showing the per cent. of variation in groups of ten tests for tensile strength. With the ordinary method of manipulation, several hundred tests show variations from the mean of each set of ten to be from 8% to 56%. But it is useless to multiply instances of this kind, for all records of cement testing show like discrepancies. In the light of these facts it is believed that variations of from 15% to 20% must be expected.

Tables IV. and V. seem to show that the coefficient "C" is very slightly reduced in the case of prisms broken a second time, but in consideration of the facts above mentioned it is unsafe to consider this as an established law.

Although the method of tensile tests, as recommended by the American Society of Civil Engineers, has great advantages, as affording a means of comparison, yet, even in the opinion of some of its originators, it is in some respects defective. Mr. D. J. Whittemore says ("Trans. Am. Soc. C. E.," Vol. 25, p. 285): "I trust our Society will reappoint a committee upon improved methods of cement tests, in the hope that a better solution of matters that appear indefinite in the former report will be reached, and at the same time methods of testing be devised which will not involve long time delay in determining results. In Eng. News, Vol. 25, p. 2, Mr. S. Bent Russell says: "It is now nearly six years since the report of the American Society of Civil Engineers' committee was presented. The longer one works with this system the higher is his appreciation of the work of that committee, and the greater his admiration for the manner in which they pass silently by the numerous pitfalls which beset the path of the young and hopeful experimenter. One must needs have courage to criticise the document, both on account of the wisdom contained in it and of the list of weighty names subscribed thereto."

A knowledge of the tensile strength is, in itself, of no importance whatsoever to engineers, and such tests are confessedly made only for the sake of comparison; and for this purpose the transverse method, if generally adopted, would have at least the same advantages besides others to be mentioned. If it is desired to know the tensile strength of cement it can be deduced from the transverse breaking strength, as will be seen from Table I., within a limit of error of 10% to 15%.

Conclusions.—The writers began these investigations into the method of transverse tests with the idea that it could be utilized as a simple and inexpensive method, where the tensile method, requiring a much more expensive machine, would not be used. The results of these experiments seem to justify going a step further, and saying that the transverse method is comparable in every respect with the tensile, while at the same time it has some very important advantages over the latter method.

Some of the most prominent of these advantages are: (1) The very insignificant cost of the transverse testing machine and apparatus, as compared with the cost of a tensile machine and molds; (2) the very great gain in the per cent. of good breaks in favor of transverse tests; (3) a perfectly satisfactory clip.

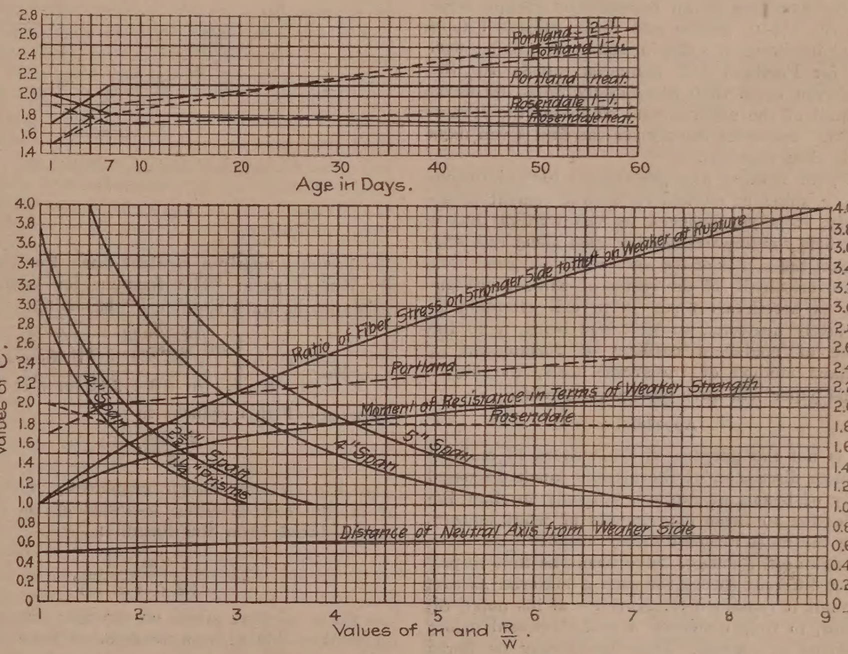


FIG. 8. DIAGRAM SHOWING GRAPHICALLY RESULTS OF TESTS.

In regard to the first claim, the expense of the complete machine, at the ordinary prices for labor and materials, should not exceed $12. The molds recommended, as shown on Fig. 4, cost $3 per set (for 16 prisms), thoroughly made and ironed. If cast iron molds are preferred, according to the design on Fig. 5, the cost (estimated at a machine shop) would be $15 for three sets furnishing one dozen prisms per set, and about $5 for each extra set thereafter.

If it is desired to test only a few prisms, the exceedingly simple device could be used of hanging the weight directly from the prism in the clip. In this case all that is required is a clip and can, into which a loading of water, sand or shot can be steadily poured. The cost of this simple apparatus should not exceed $8 (including wooden molds), and the tests would be as accurate as any made upon a more expensive machine. The Fairbanks tensile machine of 1,000 lbs. capacity, in use at this institution, cost $100, with one mold furnished, and extra molds cost $2 apiece. The least expensive Riehle machine of like capacity costs $75, and prices range from $75 to $200, one mold furnished with each machine, and extra molds cost $4 apiece. These are catalogue prices for the two makers named.

In regard to the second claim, as will appear from Table I., 700 transverse tests were made with 96% good breaks. There were made 455 tensile tests with 64% good breaks, and this per cent. is believed to be about the average usually obtained on any good tensile machine. In Eng. News, Vol. 29, p. 16, is the record of 2,000 tensile tests made on an Olsen machine, giving 65% good breaks. Mr. S. Bent Russell says (Eng. News, Vol. 25, p. 4): "The form of briquette known as the American society standard is so modeled that if three briquettes out of four break in the smallest section, one may be sure they are being fairly treated."

A tensile break was called bad only when it occurred so far from the center that the cross-section would be considerably in excess of 1 sq. in. A transverse break was called bad when very irregular or when it occurred more than ⅜ in. from the center. As the section of the prisms was uniform the fractured suface could never much exceed 1 sq. in.

Regarding the third claim, although it has been nearly eight years since the committee of the American society reported upon their method of cement testing, yet, up to date, no standard clip has been adopted, and no clip has been made which has given entirely satisfactory results. All the manufacturers of tensile machines make a differently shaped clip, which is very liable to cause a difference of results and impair the value of the comparisons—the prime object of tensile tests.

In tensile tests it is a very difficult matter so to adjust the briquette in the clip that there shall be no twist or cross strain, which is such a prolific cause of bad breaks. A very great advantage is claimed for the transverse method in this respect, as the prism rests free and clear upon its two supports and is broken by the load applied by the breaking bar in the center, and there cannot possibly be any ambiguity as to the strain. The possibility of changing the span is also a great advantage. Weak sand mixtures can be broken at a 2½-in. span, and very strong prisms of neat cement at a 5-in. span, thereby giving the former a few moments' time before breaking and economizing time in the latter case.

With the 4-in. span and 1-in. cross-section adopted, the "common theory" of flexure would indicate that the breaking weight of prisms should be one-sixth of the tensile strength of the briquettes in the same set, or in the notation adopted R-W = 6.

In Table I. it will be seen that this ratio varies from 1.8 to 4.6 for the standard dimensions, the average being about 3.0, showing that the actual breaking load for the prisms is about twice the theoretical as ordinarily computed. The column headed coefficient "C," in Table I., will show at a glance how much this "common theory" is in error. Without a single exception every set shows a strength greater than the theoretical.

From these results but one conclusion can be drawn, viz.: That all previous experimenters to whom reference has been made have seriously erred in applying the "common theory" to beams of cement broken transversely. These experimenters are not alone in this error, for there are few textbooks which go beyond the bare statement that the "common theory" applies when the tensile equals the compressive stress at the extreme fibers. Professor Johnson has recognized the true principle for cast iron. The neutral axis is usually taken at the center of gravity of the section.

The diagram, Fig. 8, shows the effect of sand on the coefficient "C" for different cements and ages. The diagram would seem to indicate that the addition of sand decreases the coefficient for the first 20 or 30 days, after which time the coefficient increases. On the same diagram are also shown the variations of "C" for Portland and Rosendale cements for different ages, using the mean of both neat cements and sand mixtures. These values are the averages of all experiments except those with the 1¼-in. prisms and those subjected to a second breaking at a 2½-in. span. It will be seen that for Portland "C" increases rapidly for the first seven days, then less rapidly up to 60 days, the limit of the experiments, while for the Rosendale "C" decreases rapidly for the first seven days and is then constant.

Without making any pretensions toward formulating a standard method for testing cement transversely, it is yet believed by the writers that a great field for improvement is open along this line, and that the merits of the system have in some way been overlooked. If the result of these investigations as herein set forth is to call attention to this lately neglected subject, and bring it to the notice of engineers capable of formulating a standard method of transverse tests, the object of this paper will have been accomplished.

Appendix.

It is not the purpose of the writers to make a complete discussion of the already much discussed theory of beams at rupture, but only to show the application to these experiments of what appears to be the most rational theory extant.

Hodgkinson seems to have been the first to propose a different theory for such a material as cast iron, but it remained for Navier and his pupil, St. Venant, to fully elaborate a really rational theory of beams at rupture. This theory may be found fully explained in a two-volume work by Navier and St. Venant, entitled "Resistance des Corps Solides."* To the authors of "Modern Framed Structures"** belongs the credit of making the first English translation of this theory.

The following brief discussion is taken largely from these two works. The theory is based on the assumption (indorsed by many good authorities) that the conditions of the fibers in a beam during flexure are correctly represented by the ordinary strain diagrams of the material, the abscissas (parallel to the beam) representing the stresses in the corresponding fibers, while the ordinates represent the strains. As the stress at the weaker side at rupture is the ultimate strength of the material, it is evident that the curve must be practically perpendicular to the axis of the beam, as shown in Fig. 9.

Now, as the areas of the strain diagrams as applied to the beams represent the total stresses in the beams, and as the tensile and compressive stresses must be equal, only that part of the strain diagram on the stronger side is used, which will make these areas equal. The moment of the couple formed by these forces, acting through the centers of gravity of the areas, must equal the moment of the external forces at rupture. In Fig. 9 are shown the strain diagrams and position of the neutral axis. Let:

F_t = tensile strength or length of tension ordinate where the curve becomes horizontal.

F_c = the same in compression.

Y_t = distance from neutral axis to tension side if failure occurs by tension.

Y_c = distance from neutral axis to the fiber which would have stress F_c beyond the limits of the beam if failure occurs by tension.

F = stress in fiber at distance Y from neutral axis on tension side.

F' = same at distance Y' on compression side.

St. Venant proposed the following equations for these curves:

$$F = F_t\left(1 - \left[1 - \frac{Y}{Y_t}\right]^m\right)$$

and

$$F' = F_c\left(1 - \left[1 - \frac{Y'}{Y_c}\right]^m\right).$$

In these formulas m is an exponent which must be so chosen as to fit the strain diagram as closely as possible. Within the elastic limit m = 1 and these equations become those of straight lines. But for cement and similar nearly inelastic substances, the strain diagram in use on the stronger side becomes nearly a straight line. For this case St. Venant says: "The formula for moment of resistance is much simplified," becoming:

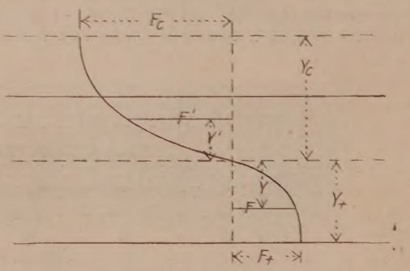


Fig 9.

$$M_0 = \frac{F b h^2}{6}\left[\frac{m\left(\frac{[3m+3]}{m+2} + 4\sqrt{\frac{2}{m+1}}\right)}{m + 3 + 2\sqrt{2(m+1)}}\right]$$

For m = 1 this reduces to

$$\frac{F b h^2}{6}.$$

In Fig. 8 are shown graphically the values of m, the corresponding positions of the neutral axis deduced from the formula:

$$Y_t = \frac{\sqrt{m+1}}{\sqrt{2} + \sqrt{m+1}},$$

the ratios of fiber stress on stronger side to that on weaker side at rupture deduced from the formula:

$$\frac{F_c}{F_t} = \frac{m\sqrt{2}}{\sqrt{m+1}}$$

and the moment of resistance at rupture in terms of the weaker strength.

The equilateral hyperbolas shown, were used to deduce the coefficient "C" from the ratio R-W for different spans and cross-sections. They were obtained as follows:

From the formula

$$\frac{W\,l}{4} = C\,\frac{R\,b\,h^2}{6},\quad C = \frac{3\,l}{2\,b\,h^2}\,\frac{W}{R}.$$

Now for the 2½-in. span and 1-in. section.

$$\frac{3\,l}{2\,b\,h^2} = 3.75;$$

hence

$$C = 3.75\,\frac{W}{R}.$$

To find C for some value of $\frac{R}{W}$, as 1.5, enter the diagram with this value and follow up the vertical line to its intersection with the curve for 2½-in. span, then follow the horizontal line to the left where the value of C can be read off, which in this case is 2.5. This diagram facilitates the calculation in a marked degree, and, of course, by plotting a sufficient number of hyperbolas the value of C for any length of span or any cross-section can be thus obtained.

PASSENGER CARS; NEW YORK CENTRAL & HUDSON RIVER R. R.

(With inset.)

One of the most attractive and interesting exhibits in the very interesting collection of modern railway equipment in the Transportation Department, at the World's Columbian Exposition, was the New York Central R. R. Co.'s train, consisting of the splendid locomotive No. 999 and three day cars, representing the equipment of the Empire State Express (Eng. News, May 18, 1893). The engine holds the two highest records of speed in the world, namely, 32 and 35 seconds per mile, equivalent to 112 and 102 miles per hour (Eng. News, May 11 and 18, 1893), with this famous train in its regular service. While all the American passenger cars at the Exposition showed excellence of construction and of equipment in the way of brakes, couplers, vestibules, etc., the three cars of the New York Central R. R. were notable for excellent design and construction combined with elegant simplicity of finish and decoration. This latter feature is specially noticeable when compared with the almost painful elaboration of ornament which marked several of the other exhibition cars, as noted in our issue of Oct. 12. The train consisted of two day cars and a combination buffet, smoking and baggage car, all of which were built at the railway company's shops at West Albany, N. Y., for service on the Empire State Express, and not for exhibition purposes only. These cars were briefly described in our issue of Oct. 12, and we publish this week the working drawings, for which we are indebted to Mr. William Buchanan, Superintendent of Motive Power and Rolling Stock.

The two day coaches are probably the largest cars yet built, being 80 ft. long over all, necessitating a heavy and substantial system of framing. The side sills are each composed of two yellow pine timbers bolted together; the outer piece being 5×8 ins. and the inner piece 3×8 ins. At each end of each sill an iron plate 8×½ in. and 16 ft. long is bolted between the two timbers, the inner one being cut to 2½ ins. thickness, and the ends of these plates are bent at right angles for a length of 8 ins. and bolted to the end sills, thus serving as corner brackets. The end sills are 8×8 ins., composed of two pieces of oak 3½×8 ins., and 3¾×8 ins., with an iron plate ¾×8 ins. between them. There are two center sills 5×8 ins., 10 ins. apart in the clear, and four intermediate sills 4×8 ins. Between these sills are bridging pieces 2½×8 ins., spaced from 15 to 25 ins. c. to c., and an intermediate floor of tongued and grooved planks ⅞ in. thick is placed at the middle of the sills, secured between strips nailed to the latter. The sills are tied together by ¾-in. rods. The crossties are 8×4 ins.; the middle ones 10 ft. 6 ins. apart, and the outer ones 9 ft. 6 ins. from the middle ones, each trussed by two ¾-in. rods. The body bolsters have upper members ½×6 ins., and lower members ¾×6 ins. The frame is trussed by four truss rods 1½ ins. diameter, upset to 1¾ ins. at the ends, the truss depth being 18¾ ins.

The body framing has compression beams and end counter braces 7½×1½ ins., with ¼×1½-in. iron plates at the joints. The body braces are 4×2 ins., with a ¾-in. brace-rod from the top of each brace to the underside of the sill. The belt rail is 5½×1½ ins., and the studs are 1¼×4 ins. The window posts are of two pieces, 1¼×4 ins., placed 5½ ins. apart, with blocking between them, and each post has a ⅝-in. rod from sill to side plate. The plate is 3×4 ins. The carlines are 1⅜ ins. thick, 11¼ ins. c. to c., and those over alternate window posts are in pairs, with a ½×2-in. iron carline bolted between them. There are 22 large windows, with glass 26×33 ins. The roof is of tongued and grooved planks ⅞ in. thick, covered with canvas. The monitor roof is wide and rather shallow, and the lower deck is deeply curved. The floor is double, consisting of a layer of transverse planks ⅞×8 ins., and a floor proper of tongued and grooved pine flooring boards ⅞×2¾ ins. The cars are vestibuled, and have the Gould vestibule, platform and coupler.

The trucks are of the standard passenger type, and have six wheels 36 ins. diameter. The spring beams are 9×9 ins., made of three pieces, and the spring planks are 12×3 ins. The bolsters are

---

*Paris, 1864.

**Johnson, Turneaure, and Bryan. J. Wiley & Sons, 1893.

16 × 8 ins., made of three timbers and two iron plates. Both elliptical and helical springs are used. There is a brakeshoe to each wheel, and metal brakebeams are used. The side bearings on the truck frames are fitted with springs, so as to give an easy movement of the body in passing round curves.

The exterior sheathing is in narrow vertical strips and is painted Tuscan red, with gold and black lettering. The trucks are painted dark brown. The interior is finished in mahogany, with a minimum of carving and decoration. The headlining is painted in white and gold. The floor is varnished and a carpet is laid in the aisle. The upholstering of the day cars is of copper-red figured plush, while that of the smoking car is of brown corduroy. The general effect is very handsome and pleasing, while the white headlining and the extent of window area imparts an unusually bright and cheerful appearance. The seats are by Hale & Kilburn, and each is fitted with a brass umbrella ring, while the back has a brass rail for coats and wraps, and a plush pocket for books and papers. Fittings are also provided for portable tables between the seats. The men's lavatory is open, but shut off from observation by a wide partition, and over this lavatory is placed the conductor's brake valve. The baskets for hand baggage are of light bronze, but it would have been better to use a continuous baggage rack of heavy brass wire, as on some of the cars of the New York, New Haven & Hartford R. R. (Eng. News, Nov. 3, 1892). Such a rack is much more convenient than the ordinary brackets over alternate seats. The Canadian Pacific Ry. day car at the Exposition had a continuous rack, but unfortunately it was a flat wooden shelf with a raised edge, giving a very clumsy and heavy appearance, and forming a receptacle for dust. The cars are heated by steam and lighted by the Pintsch compressed gas system, there being seven lamps in each day car, four lamps in the smoking compartment of the buffet car, and a lamp in the hood over each platform. The windows have single sashes and spring blinds.

The general particulars of the day cars are given in the accompanying table, and those of the buffet car are similar, with the following exceptions: Length over platforms, 77 ft. 2½ ins.; distance c. to c. of trucks, 54 ft. 0 ins.; weight, 92,000 lbs.; seating capacity, 48 passengers.

Length over platforms	80 ft.	0 ins
“ “ end sills	71 “	11 “
“ “ buffers	79 “	3½ “
“ inside	71 “	1½ “
Width over body	9 “	11 “
“ “ side sills	9 “	10 “
“ “ roof	10 “	2⅛ “
“ “ monitor roof	6 “	2½ “
“ inside	9 “	½ “
Height, rail to c. line of coupler	2 “	11 “
“ “ “ top of sill	4 “	2 “
“ “ “ “ “ roof	14 “	3 “
“ inside at sides	6 “	6 “
“ “ “ center	8 “	3¼ “
Wheels, diameter	3 “	
Journals	4¼ ×	8 “
Wheel base, truck	10 ft.	6 “
“ “ total	62 “	5 “
Distance c. to c. of trucks	55 “	11 “
Weight of body	62,200 lbs.	
“ “ two trucks	33,200 “	
“ total	95,400 “	
Seating capacity	84 passengers	
Approximate cost	$8,720	

NEW YORK & BROOKLYN BRIDGE IN 1893.

The report of the Trustees of the New York & Brooklyn Bridge for the year ending Dec. 1, 1893, is just issued, and the following is an abstract of its chief features:

The number of passengers carried by the railway in 1893 numbered 46,615,105, an increase of 842,207 over the traffic of 1892. The receipts from the railway were $1,167,497.65, and from tolls on the carriageway, $85,410.39, a total of $1,252,908.04. This total is $24,179.03 in excess of the receipts for 1892. The receipts from all sources for 1893 was $2,029,451.56; including in this as chief items in addition to tolls a balance on hand at date of last report of $439,311.53; from the cities of New York and Brooklyn, on construction account, $225,000, and $109,246.05 from rent, real estate and telegraph wires. During the last year $222,949.58 were expended on construction account, the chief items being as follows: Brooklyn extension, $26,588; New York extension, $13,771; new engine house, $16,856; new engines, $58,970; Brooklyn station, $61,096. The total expenses for the Dubois suit for alleged infringement on caisson patents, which was decided in favor of the trustees, amounted to $24,250.

Under the head of the Liberty St. extension and Plaza improvement, we find that all real estate required for these improvements has been paid for, excepting three parcels, and only one of these is now in litigation. Under the terms of the act authorizing this improvement the city of Brooklyn is to pay for the work, and the trustees have consequently drawn from the city treasury the sum of $1,450,000. Of this sum $1,416,046 has been paid out for real estate, legal expenses, cost, allowances, etc.

From a diagram given showing the monthly fluctuations of passenger traffic on the bridge, we find that for the first time since the bridge was opened in 1883, there was a decrease in traffic in any one month, as compared with the corresponding month in a preceding year. This decrease commenced in the early part of August and has remained below the record for 1892 to Dec. 1, and even struck below the 1891 line in October. The number of passengers carried in the whole month of October, 1893, was 3,644,053, only 21,037, or about one-half of 1%, greater than in October of 1891. On the other hand, the traffic of this year, until about June 1, was largely in excess of the corresponding months of 1892.

During certain days of the year the number of railway passengers for each hour of the day, to and from New York, was noted with some interesting results. The chief traffic from Brooklyn sets in between 6 and 7 a. m., and by 10 a. m. about 50% of the total traffic for the day from that direction has passed over. This 50% returns from New York between the hours of 4 and 7 p. m. In each day thus noted, it is observable that the railway carried about 6,000 more passengers to New York than it carried back to Brooklyn, the explanation being that while many passengers hurried to their work in the morning by rail, they walked home over the bridge in the evening. The same division of morning and evening traffic takes place on the elevated railways of New York.

From the opening of the railway, on Sept. 24, 1883, to December 1, 1893, 304,875,286 passengers have been carried. The greatest number transported in any one month was 4,033,920, in October, 1892, during the Columbian festival. The maximum for any 24 hours was 223,623, on Oct. 12, 1892. During the present year the total time lost by delay in running trains was 4 h. 35½ m., an average of 45¼ s. for each day of 24 hours, or one minute for 154,668 passengers carried. Of this total delay only 38% was due to failure of or defect in parts of the cable-hauling machinery; the remaining 62% was chargeable to accidents common in ordinary railway transportation. Grip failures produced but seven delays, aggregating a loss of 1 h. 9 m. No one has yet been fatally injured in transit.

In the 10 years and 67 days of operation of the railway eight hauling cables have been in use, of which six have worn out and been removed. The first cable was in service 1,140 days, but the average load hauled was only 97 tons. The load has constantly and rapidly increased until No. 6 cable, lately removed, after 509 days' use, had a record of an average load hauled of 321 tons. The average for the two now in use is 323 tons. In this period of 10 years' operation the average ratio of live to dead load hauled has increased from 6 to 9.3. The six 22-ton switching engines, used originally, had a necessarily long wheel base and rapidly wore out rails and flanges on the curves and switches. To obviate this difficulty and to meet a demand for more power a new engine has been designed and the first one is now in use. This new engine has four driving and four truck wheels, one pair of the latter being pivoted to and placed at each end of the locomotive frame. It weighs loaded 34½ tons, and, on dry rails and under favorable circumstances, it can haul at cable speed (10⅓ miles per hour) a train of four partially, or three fully, loaded cars up the maximum 3¾%-grade on the bridge. This is equivalent to a load of from 85 to 100 tons.

Regarding the proposed extensions of the bridge the report states that in obedience to the resolution passed Oct. 13, 1893, all work on the Brooklyn station is suspended pending the modification of the plans to meet a demand of citizens that changes be made in those originally presented.

PERSONALS.

Mr. Wm. A. Burr, of New Albany, Ind., has been appointed surveyor of Floyd County, Ind.

Mr. A. T. White has been appointed Commissioner of City Works of Brooklyn, N. Y., by the mayor-elect, Mr. C. A. Schieren.

Mr. George J. Parkin has been appointed Master Mechanic of the Erie & Ashtabula Division of the Pennsylvania lines west of Pittsburg.

Mr. Tracey, City Engineer of Vancouver, B. C., has resigned, and it is reported that the city will advertise for a city engineer at a salary of $150 per month.

Maj. H. B. Du Barry, Engineer of Property for the Pennsylvania R. R., died Dec. 2 in Pittsburg. He was at one time assistant engineer of the Pittsburg, Cincinnati, Chicago & St. Louis R. R.

Mr. William F. Fitch, General Manager of the Duluth, South Shore & Atlantic R. R., has also been appointed General Manager of the North Star Construction Co. operating the Duluth & Winnipeg R. R., vice Mr. William H. Fisher, resigned.

Mr. William Renshaw has been appointed Superintendent of Machinery of the Yazoo & Mississippi Valley R. R., and Mr. J. J. Casey has been appointed Assistant Superintendent of Machinery. Both will have offices at Chicago, the line being owned by the Illinois Central R. R.

Mr. Anthony Reckenzaun, the prominent electrician, who is best known for his work in developing and introducing the storage battery, died Nov. 11, in London, England. He was born at Gratz, Austria, in 1850. and went to London in 1872, where he procured employment with a marine engineering company. After attending the Paris Exposition in 1878, he studied electrical engineering under Professor Ayrton, in London, and the Electrical Exhibition at Paris in 1881 enabled him to become thoroughly acquainted with electrical apparatus in general. His work in connection with practical storage battery applications has been of considerable value. In 1886 he built the electric launch "Volta," which made trips from Dover to Calais and London to Dover. He did considerable work in this country in connection with accumulators for launches and street cars.

Mr. Henry Goebel, who claimed to have invented the incandescent lamp before Edison, died in New York, Dec. 4. His claim has been an important one in suits for and against the Edison company. His first experiments, made in Hanover in 1846 were failures, but in 1850 he made more extensive experiments in New York and constructed efficient lamps consisting of cologne bottles with wire filaments, and later with carbonized wood fiber filaments of horseshoe shape. He was born in Springer, Germany, in 1818, and came to New York in 1849. In 1881 he was interested in a company organized to manufacture electric lamps, but the company failed. The final decisions in suits brought by the Edison company for infringements of its patents, in which the Goebel lamp was used as an argument by the defendants, have not yet been handed down by the courts.

Mr. Joseph D. Potts, M. Am. Soc. C. E., died at Milton, Pa., Dec. 3. He was born at Springton Forge, Pa., Dec. 4, 1829, and commenced his career as an engineer on the Sunbury & Erie R. R. in 1852. Later he was made Vice-President of the Steubenville & Indiana R. R. and Superintendent of the Western Division of the Pennsylvania R. R. In 1861 Governor Curtin appointed him Chief of the Transportation and Telegraph Department of Pennsylvania, which position he held until December, 1861, when the work of this department was transferred by the state to the Federal government. During 1862-65 he was General Manager of the Philadelphia & Erie R. R. for its lessee, the Pennsylvania R. R. Co. In 1874 he became Managing Director in the National Storage Co., and in 1879 President of the National Docks Ry. Co. A few years ago he became part owner of the Potts Brothers' Iron Co., of Pottstown, owning and operating a rolling mill in that place. In 1890 he purchased the Chester Pipe & Tube Works. He was a director in the International Navigation Co.

NEW PUBLICATIONS.

A TEXTBOOK ON ELECTRO-MAGNETISM AND THE CONSTRUCTION OF DYNAMOS. Vol. I. By Dugald C. Jackson, B. S., C. E., M. Am. Soc. M. E., M. Am. Inst Elec. E., etc., Professor of Electrical Engineering in the University of Wisconsin. New York: Macmillan & Co. 12mo; cloth; pp. 289; 132 illustrations; $2.25.

This volume is, as its title indicates, a textbook for use in technical schools, and it would be "hard reading" to a student undertaking the study of electricity without the aid of a competent instructor unless the student were familiar with higher mathematics. The author has confined himself pretty closely to the subjects covered in his title, and even limits himself to direct current dynamos. Alternating dynamos and direct-current machines for series arc lighting he intends to discuss in another volume. The author expresses the hope, in his preface, that the logical arrangement and the omission of all unnecessary details will make the book of so convenient a form as to lead to its general indorsement as a reference book. The book does seem to have a logical order in its treatment of its subject; but so far as we have observed the books which are most used for reference are those which make less use of the calculus than does this author.

SOCIETY PROCEEDINGS.

MICHIGAN ENGINEERING SOCIETY.—At the annual meeting of the Board of Directors the ballots for officers were canvassed and the following persons declared elected: President, E. W. Muenscher, of Manistee; Vice-President, Geo. S. Pierson, of Kalamazoo; Secretary and Treasurer, F. Hodgman, of Climax; Directors, John J. Granville, of Saginaw; Dorr Skeels, of Grand Rapids, J. B. Davis, of Ann Arbor. The annual convention will be held in Jackson, Jan. 2, 3 and 4, 1894, and the president and secretary have already secured promises of papers as follows: A. L. Reed, "Methods of Irrigation"; Geo. L. Wells, "Manufacture, Use and Tests of Wooden Pipe"; H. G. Rothwell, "Methods of Quarrying"; C. Holmes, "The Bayport Quarries"; James Blair, "The Michigan and Ohio Boundary"; J. B. Davis, "The New York Boundary Surveys"; O. H. Todd, "Reclamation of Swamp Lands"; W. G. Fargo, "Tile Making"; E. Sellers, "Sewerage Assessments"; W. R. Coats, "Purity of Water Supply."

AMERICAN FORESTRY ASSOCIATION.—The twelfth annual meeting will be held in Washington, D. C., Dec. 15, in the Department of Agriculture. The morning and afternoon sessions will be devoted to the regular business of the Association; reports of secretary, treasurer and committees, election of officers, etc. A call on the Secretary of the Interior and a hearing before the Public Lands Committees of the House and Senate will be arranged to urge the desired legislation on behalf of forest reservations and public timber lands in general.

The evening session will be a joint meeting of the American Forestry Association and the National Geographic Society at Geographic Hall, Builders' Exchange. The Secretary of Agriculture, Hon. J. Sterling Morton, president of the Association, will preside and speak. The Hon. Hoke Smith, Secretary of the Interior, is expected to be present and to express his interest in the forestry movement. Mr. B. E. Fernow, Chief of the Forestry Division of the Department of Agriculture, will give an illustrated lecture on "The Battle of the Forest."

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Dec. 2, a visitor, Mr. Max Uhlmann, read a paper on "Some Novelties in Bevel Gearing," in which he described the method of designing and cutting bevel gears with involute teeth, so that one wheel would be able to gear with several pinions of different diameters and numbers of teeth. His remarks were illustrated by a handsome collection of cut gears, including spur wheels, bevel gears with spiral teeth, normal bevel gears with involute teeth, and the abnormal pinions (cut by a machine designed and built by Mr. Hugo Bilgram) which could gear with the same wheel used to drive other pinions.

A model was shown consisting of a normal wheel 6 ins. in diameter, with a normal pinion 3 ins. in diameter, and two abnormal pinions of diameters 2 and 4 ins. respectively, all gearing with it, and running with a remarkable degree of smoothness and noiselessness. It was shown in the discussion, however, that the meshing in the latter case was theoretically by point contact, although for small powers the wheels seemed to operate quite as well as with line contact, and, indeed, the practical difference was hardly perceptible.

In the discussion on the riveting pressures required for bridge and boiler work, Mr. Henrik V. Loss exhibited a number of indicator cards taken by him from a bridge riveter at the Pencoyd Bridge Works a couple of years ago, by using a common steam indicator in connection with a pressure producing cylinder. These showed great variations in pressures existing with rivets of one dimension, amounting to about 50% for ¾-in. rivets and 25% for larger ones. Although it is almost useless to try to formulate definite rules for the power necessary to do the work, it will be seen that if the average be introduced in comparing the two sizes, this average pressure amounts to about 1,800 lbs. per sq. in. on a 10-in. cylinder, which, when subtracting the pullback, gives 65 tons for either ¾ or ⅞-in. rivets. In many cases of upsetting a small rivet requires greater power than a large one, probably due to the rapid cooling effect of the surrounding cold dies upon the heated bar. A greater pressure, however, is necessary for boiler work, and ¾ or ⅞-in. rivets with grips like those used in bridgework, would require at least 75 to 80 tons, although for the smaller grips that usually prevail a pressure of 65 tons for the above dimensions would be sufficient. Upsetting a short rivet is a fair test of the strength of metal, for which definite rules can doubtless be laid down for the power required with reference to the diameter, but with long rivets this becomes almost impossible, as it can readily be supposed that for each length there is a corresponding diameter, which will give the smallest resistance per square inch of metal, a fact which was corroborated by the great irregularities in power lines of the cards shown that were taken from this class of work. With regard to the energy consumed a ¾-in. rivet needs about 7,200 ft. lbs., while a ⅞-in. rivet requires about 9,500 ft. lbs. to form a head and fill the hole, if the work is about in the same proportion of the squares of the diameters. Whether this relation holds good for other dimensions will have to be determined by further experiment. It has been observed also that the energy in foot-pounds necessary to upset a rivet and the displacement of metal in the rivet due to the upsetting are in the same ratio.

Mr. James Christie had observed that the pressure required to upset small rivets is very much larger per unit of area and sometimes absolutely greater than for large rivets. It is very important to consider in this connection the character of the holes and the resulting resistance to flow of the metal. With 1¼-in. rivets he had always found a pressure of 150 tons amply sufficient to make a tight joint and have the rivets fill the holes. The latter is the main consideration, and to accomplish it, it would seem that the higher the pressure the better, up to a point where the plates would be put under dangerous tension by the expansion of the rivet body.

Mr. S. M. Vauclain: A very important point to be considered is the condition of the rivet itself before being driven. It should be at exactly the right heat, and this is difficult to determine except by repeated trials. With iron rivets and poorly made holes we have found in boilerwork that it does not take very heavy pressures to fill the holes, provided the rivets have been properly heated. In a test made at the Baldwin Locomotive Works, six plates of ⅝-in. iron were drilled with holes of diameters varying by ⅛-in. from ⅝ to 1⅛ in., and riveted with pressures varying from 25 to 100 tons. It was found that the best pressures to use for different sizes of rivets were as follows: For ⅝-in., 25 tons; for ¾-in., 33 tons; for ⅞-in., 50 tons; for 1-in., 66 tons; for 1⅛-in., 75 tons, and for 1¼-in., 100 tons. He had found that the rivet to make a close joint should be hotter under the head than at the end; and if it is equally heated the end is cooled by dipping it in water immediately before inserting it in the plates.

Mr. Jeffries (visitor): A series of exhaustive experiments were made at the naval dockyards in England, which gave results almost identical with those described by Mr. Vauclain. Several years ago it was found that with thicknesses of ⅝ and ¾ in., plates closing was entirely unnecessary, but with 1-in. plates and thicker it seems at least to be very desirable. The difference of opinion on this subject is probably due to the lack of uniformity in the method of operating the closing and riveting pressures successively. The closing pressure should be maintained for just the right length of time and then the pressure transferred to the rivet. A press to do this accurately has been designed, but is not yet used extensively in practice.

Mr. Wilfred Lewis: William Sellers & Co. have built a machine in which the pressure can be accurately managed by the operator, so as to be applied first to closing and then transferred to the rivet. He read a letter from Mr. John T. Boyd, in which he spoke of hydraulic riveting as being preferable when it can be used, and recommended a plate closer when there was not absolute certainty of the riveting machine making tight work without it. He also favored an accumulator in which the weights can be dropped to vary the pressure applied to rivets on plates of varying thickness as opposed to one which furnishes uniform pressure for all kinds of work. He quoted excellent results obtained in riveting with pressures not exceeding 20,000 lbs. per sq. in. of area covered by the formed head of the rivet, but believed that the make of rivets and the thickness of plates should be taken into account to secure the most satisfactory results. A great degree of uniformity in heating rivets can be obtained with an oil or gas furnace.

Mr. James Christie: We had found in bridgework, in driving rivets of ⅞ to 1 in. diameter through thicknesses of 5 or 6 ins., that it was best to use a plain bar and form a head on both ends at the same time.

Mr. John Birkinbine: From what has been said it would seem that the most important feature, namely, the quality of the iron in the rivets, is often neglected in its consideration: but in locomotive boiler and in bridgework, where many lives are dependent upon it, it would seem that nothing but the best quality obtainable should be considered as fit for use.

L. F. Rondinella, Secy.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—(Annual meeting—Concluded from p. 453).—Wednesday morning's session was devoted to papers relating to indicators. Prof. R. C. Carpenter's paper on "Constants for Correcting Indicator Springs that Have Been Calibrated Cold" came first. The paper described tests which had been carried out by two post-graduate students at Cornell, to determine the average percentage difference in the reading of indicators when calibrated hot and cold. Neglecting some indicators which gave an abnormal result on account of defects of construction, the difference was found to vary from 2.5% to 4.4%, and the final mean percentage difference between the hot and the cold tests was 3.6%. The investigation indicated that it is practically impossible to construct a spring and accessory moving parts of an indicator to give a diagram perfectly accurate for any prescribed scale. In general it appears that new indicators gave diagrams agreeing more closely with the scale than old ones, and also that while some makers of indicators calibrate their springs cold, others calibrate them hot. Mr. Chas. T. Porter, honorary member of the society, took part in the discussion on this paper, which was also participated in by Messrs. Cary, Almond, Barnaby and others.

A paper by Prof. W. S. Aldrich on the use of the indicator for general dynamometric testing followed. The nature of the paper is well indicated by its title, and it hardly admits of abstract save to say that the author has made a variety of applications of the indicator for the measurement of power with much success. Professor Carpenter pointed out the difficulty in using an indicator to measure the pressure in a closed system on account of leakage past the piston, and then read a paper entitled "A New Form of Prony Brake" (reprinted in our last week's issue). Prof. D. S. Jacobus then presented a paper, in which the mean effective pressure of cards taken simultaneously by different indicators was compared. The conclusions reached from the tests were summarized as follows:

1. With correctly fitted pistons in the indicators there need be no greater error involved in their use than that which occurs in measuring the hot scales of their springs.

2. A leaky piston is much more reliable than one that is too tight a fit. A piston that will fall through the cylinder by its own weight may be too tight and produce errors due to undue friction. The friction of an indicator piston should be so small that there will not be over the thickness of a very fine pencil line between the lines obtained for a rising and falling steam pressure in the tests to determine the hot scale of the springs.

3. The greatest difference found between two indicators with correctly fitted pistons for the mean effective pressures of cards taken at one-quarter cut-off was, as a maximum, 0.9%, in four indicators tested, and the greatest difference in the measurement of the mean height of the diagrams for any two indicators was .005 in. This was for comparative tests in which the average of either 12 or 24 cards was taken. The greatest difference between any single pair of indicator cards taken simultaneously was 2.5% of the mean effective pressure, and the corresponding difference in reading the mean height .017 in.

4. The greatest difference found between any two indicators with correctly fitted pistons for the mean effective pressures of cards having 1-40 cut-off, so that a loop was formed below the atmospheric line, was 0.6 lb. per sq. in., and the greatest difference in the measurement of the mean height was .010 in.; or, adding opposite signs, .017 in. The presence of a loop causes the effect of friction and lost motion to be a maximum, and the above differences are, therefore, greater than were found in cards having no loop.

5. The variation of the weight of the moving parts within the limits now employed by the makers of the standard instruments does not affect the accuracy of the results obtained by the indicators.

The question was presented for discussion, "What is the best method of determining the power consumption of an engine working under loads varying suddenly between wide limits, as, for example, in rolling mill work?" Should cards be taken at frequent and regular intervals and then averaged, or is it better to keep the paper on the drum until several cards have been drawn on the same paper and then estimate where the average of the several cards will be found? Messrs. Kent, Rockwood, Dutton and Platt expressed preference for the several cards taken on one paper; but Mr. Daniel Ashworth, whose experience in rolling mill work has been very extensive, preferred to take successive cards, as rapidly as possible. Mr. F. H. Ball, whose experience with the variable loads of electric lighting and railway stations gives his opinion much weight, also favored separate cards. The discussion then drifted on to the use of instruments specially designed to record the power developed by engines in the shape of a continuous card, from which the total work done in a given time can be directly measured. Cornell University has just secured a new instrument of this type which bids fair to be a success.

The discussion of topical questions was then taken up as follows:

Does copper undergo a change from prolonged service which renders it unsafe after a while to carry high pressure steam in pipe or expansion joints ?

In answer to this question it was pointed out that the relation of experience in this matter would be of little value unless it were known what sort of impurities the copper contained. Ordinary commercial copper varies in its character very considerably on this account.

How far can hydraulic (or other) pressures be advantageously substituted for the drop press in the manufacture of small stamped metal articles, either by hot or cold treatment ?

In reply to this Wm. Kent submitted a rough computation showing that a hydraulic press of enormous size and cost would be required to give pressures equal to those obtained by a small and inexpensive drop hammer.

What is the best mode for packing the rods and plungers of hydraulic machinery, particularly under high pressure ?

A long and interesting discussion was had on this question. Cup leathers seem to be generally favored for hydraulic work, but there is leather and leather, and as much care should be taken in the design of the stuffing box and the leather as in any part of the machinery. The discussion was notable for the presentation by President Coxe of a very novel pump plunger packing for mine pumps moving acid water. We shall illustrate and describe it shortly.

On Wednesday evening a reception was held at Sherry's, and the beautiful ballroom was crowded with the members and their friends.

Thursday's Session.

The members met on Thursday morning apparently stimulated to more active discussion by the recreation of the night before. Mr. Gantt's paper on steel casting was first on the list, and was in a certain sense a continuation of the paper by the same author read at the Providence meeting and published in full in Engineering News, June 20, 1891. Considerable time was taken up in a discussion between Messrs. Gantt, Durfee and Taylor, each of whom has been at different times in charge of work at the Midvale Steel Co., over the records of steel casting done there. We shall abstract Mr. Gantt's paper in a later issue.

Secretary Hutton then read a paper by Wm. A. Pike on "Steam Piping and the Efficiency of Steam Plants." The principal point made by the author was that by attaching a receiver to the pipe close to the engine, a large part of the drop in pressure at the engine could be avoided, with a great improvement in the amount of power developed and the economy of the plant. President Coxe corroborated the author by describing a plant at one of his collieries where steam is carried over a mountain a distance of about 4.500 ft. through a 6-in. pipe and with a drop of pressure of only two or three pounds. A large receiver is placed at the end of the pipe, serving both as a reservoir for steam and a trap for condensed water. He took care of expansion by making a right angle bend of a large radius in the pipe at intervals of 1,000 ft. or so. Mr. Pearson described the steam piping which he had installed at the Schenectady shops of the General Electric Co. to carry 160 lbs. of steam. He uses cast iron pipes of extra weight, with joints ground metal to metal and no packing. He described a visit to the electric stations in a large number of the principal cities and said that he had not found one where leaking steam was not present from defective joints.

The discussion served to bring out the fact that the arrangement of the piping is one of the most important features in the design of a steam plant, and that the essential points are, as stated by the author of the paper:

(1) The piping and accessories should be so arranged that practically dry steam shall always be delivered to the engine.

(2) The steam should reach the engine with very little "drop" in pressure.

(3) The piping should be so planned and valves so placed that water cannot under any circumstances collect anywhere, except in places especially arranged for that purpose.

(4) Wherever practicable, and especially where more than one engine is supplied from one battery of boilers, the piping and valves should be arranged so that in case of accident to any part, it can be shut off without shutting down the whole plant.

To this may be added ample provision for expansion and contraction, and a form of piping and of joints which will be both steam tight and secure.

A paper by Mr. Chas. H. Manning followed, giving his experience in making large steam pipes by adopting practically boiler-construction methods, steel sheets being bent and riveted to form the separate lengths and the lengths being slightly tapered so that the small end of one length fits inside the large end of the next length. He uses ¼-in. sheets with double riveted longitudinal seams and single riveted circumferential seams. Above 160 lbs. pressure he double rivets the latter also.

Friday.—Concluding Session.

The meeting opened with a mathematical paper by Jas. B. Stanwood, of Cincinnati, on the "Strength of Rim Joints in Flywheels." It was supplementary to a paper on the same topic by Mr. Stanwood, read before the society a year ago (Eng. News, Dec. 8, 1892). This was followed by another mathematical paper by Mr. Wm. A. Rogers on "The Cumulative Errors of a Graduated Scale." There was no discussion. A paper by Mr. W. H. Francis describing "A Modern Disinfecting Plant" followed, and then came a brief paper by Mr. W. E. Crane on a crucible furnace for burning crude petroleum. He had found that there was a saving of about 30% in the fuel cost compared with egg coal. We shall abstract these papers in another issue.

Mr. F. A. Scheffler presented a paper recording a boiler test in which grates with only ⅛ in. openings were used, and the total area of openings in the grate was only 15% instead of 35% to 45%, as is customary. The test showed excellent results and the author thought it a fair conclusion that the grate openings were adequate notwithstanding their small size. Mr. Cary said he had used grates with 5-16 in. openings and found a great reduction in the draft necessary to make steam when ⅝ in. openings were substituted.

Prof. R. C. Carpenter then read a paper describing experiments on the effect of water in steam on the economy of a steam engine. He concluded from the test that while for mechanical reasons and for its effect on the boiler economy, water in the steam was undesirable, when once in the cylinder the effect of water in steam on the economy of the engine was practically nil. Mr. F. H. Ball thought this conclusion reasonable, especially as it agreed with the results of tests made by Prof. J. E. Denton and reported to the American Association for the Advancement of science. Mr. D. L. Barnes thought that while the tests were correct for the small, slide-valve throttling engine used, different results might be obtained with a large compound or triple expansion engine.

The final paper on the list was a "theory of direct acting steam pumps." Its author proposed to use what Chas. S. Porter has called "a reciprocating flywheel," to enable a short cut-off to be given. Professor Sweet pointed out that there were serious practical difficulties in the way of accomplishing what the author proposed.

The remainder of the session was devoted to the discussion of topical questions as follows:

What is the best method of correcting for the superheating of steam in figuring a boiler test?

Professor Carpenter said that he knew of no reason for departing from the method laid down in the Society's standard code for boiler tests.

Will there be any difference in the size of chimney required when the boilers are the ordinary tubular type, or of some of the water-tube forms?

Mr. Samuel Webber thought a somewhat larger chimney would be required for the water-tube boilers. Mr. Cary recommended Wm. Kent's formula as giving good proportions for water-tube boilers.

What is the best form of cylinder lubrication for engines carrying 140 lbs. of steam or over?

Mr. Webber recommended a sight feed lubricator. Mr. W. F. Matteshall had best results with the Lackawanna locomotive lubricator.

What are the maximum safe speeds for hoisting and traversing in an overhead traveling crane in a machine shop?

Mr. Webber said that the Shaw electric crane in the Pond Machine Tool Works has a longitudinal travel of 400 ft. per minute; the trolley moves at 200 ft. per minute and the load can be hoisted at 50 ft. per minute.

Is there any advantage in using a circulating device for the water inside a boiler, particularly of the three furnace Scotch form?

Emphatically, yes, was the answer made to this by Messrs. John H. Cooper and Alfred H. Raynal. The latter stated that the Pennsylvania R. R. is now using on its floating equipment in New York harbor an arrangement by which the feed pump causes circulation by an ejector action. Mr. Cooper also said in reply to the next question (What is the best method of grouping tubes over the furnace of a Scotch boiler?) that tubes should be arranged in vertical rows with ample space for the circulation between them.

Will a forced circulation of air under a floor near the ground prevent decay of the woodwork and floor timbers?

Messrs. W. W. Dingee, C. J. H. Woodbury, W. F. Durfee and Robert Cartwright discussed this and agreed in the importance of good ventilation to prevent decay of timber. It should be noted, however, that when decay has once begun it is doubtful whether ventilation alone can stop it.

Have you any facts to show that there is a molecular change in metals when their temperature is raised or lowered?

Mr. Cary related experience showing that iron or steel when put under moderate strain and heated will take a permanent set at temperatures as low as 600°.

Have you any data as to earthwork dams which would suggest the factor of safety with which they have been built?

Mr. J. M. Goodell said that earth dams almost invariably failed on account of faults of detail, so it was difficult to say what was a proper factor of safety.

The facts brought out by the remaining questions may be summarized as follows:

A certain amount of compression is of advantage in a high-speed automatic engine.

Japanning as a protection of steel from corrosion proved in one case to be far superior to either copper or nickel plating, and in fact left little to be desired.

Recutting files does not pay on ordinary cheap files. It does pay well on the very best high-priced files, which will do 20% to 30% more work in a given time than the cheap files, and will last enough longer to pay their extra cost. Files of good material can be recut at least twice.

Copper has been successfully used at New Britain, Conn., as a material for small chills in iron foundries. Its rapid conduction of heat causes a deep chill, and it expands when heated, so that it can be readily removed from the casting.

A cheap and very fair non-conductor is made by mixing sawdust and plaster of paris. Its chief fault is that it is injured when repairs are necessary and has to be replaced new when disturbed.

Prof. D. S. Jacobus descibed an improvement in planimeters of his invention, consisting in the substitution of crossed lines on the under side of a glass plate for the tracing point commonly used. Dr. Waldo presented the members some specimens of aluminum bronze castings having a tensile strength of 90,000 lbs. per sq. in., with 15% elongation. This closed the proceedings of the convention.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 16. Secy., L. F. Rondinella, 1122 Girard St.

SWEDISH ENGINEERS' CLUB.
Dec. 16. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

COLUMBIAN ENGINEERING SOCIETY.
Dec. 19. Secy., F. W. Hart, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 19. Secy., R. H. Clark, Pittsburg.

WESTERN RAILWAY CLUB.
Dec. 19. Secy., Clement F. Street, Chicago.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
Dec. 20. Secy., L. J. Carmalt, Roanoke, Va.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 20. Secy., S. E. Tinkham, 36 Broomfield St.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 20. Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Dec. 20. Secy., Arthur Thacher, Odd Fellows' Building.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 21. Secy., C. H. McLeod, Montreal, P. Q.

ENGINEERS' CLUB OF CINCINNATI.
Dec. 21. Secy., J. F. Wilson, 24 W. 4th St.

NEW YORK RAILROAD CLUB.
Dec. 21. Annual meeting. Secy., John A. Hill, Temple Court.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Dec. 21. Secy., Allen Strale, 100 Washington St.

DENVER SOCIETY OF CIVIL ENGINEERS.
Dec. 26. Secy., F. E. King, Jacobson Block.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Jan. 1. Secy., C. L. Annan, City Engineer's Office.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Jan. 2. Secy., W. Halliburton.

INDIANA ENGINEERING SOCIETY.
Jan. 2, 3 4. Annual meeting at Indianapolis. Secy., W. P Carmichael, Williamsport, Ind.

MICHIGAN ENGINEERING SOCIETY.
Jan. 2, 3, 4. Annual meeting at Jackson. Secy., F. Hodgman, Climax, Mich.

WESTERN SOCIETY OF ENGINEERS.
Jan. 3. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 4. Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 5. Secy., E. K. Smoot, 808 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 5. Secy., O. Von Geldern, 719 Market St., San Francisco.

ENGINEERS' CLUB OF KANSAS CITY.
Jan. 8. Secy., Waterman Stone, Baird Building.

WISCONSIN POLYTECHNIC SOCIETY.
Jan. 8. Secy., M F. Schinke, City Hall.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Jan. 9. Secy., F. C. Osborn, Case Library Bldg.

NORTHWEST RAILROAD CLUB.
Jan. 9. Secy., W. D. Crosman. Ryan Hotel, St. Paul.

NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 9. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Jan. 10. Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
Jan. 10. Secy. F. M. Curtis, P. O. Box 1576, Boston.

ENGINEERING ASSOCIATION OF THE SOUTH.
Jan. 11. Secy., Hunter McDonald, Nashville, Tenn.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Jan. 11. Secy., F. W. Mowbray, Norton Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Jan. 12. Secy., D. W. Meeker, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 13. Secy., G. O. Foss, Helena.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 18. Secy., S. A. Charpiot, Macon, Ga.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS
Jan. 19. 201 Washington Building.

CENTRAL RAILWAY CLUB.
Jan. 24. Secy., S. W. Spear, Buffalo, N. Y.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.
Entered at the Post Office, New York City,
as Second Class Matter.

VOL. XXX. THURSDAY, DEC. 14, 1893.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, C. S. HILL } ASSOCIATE EDITORS
GEO. H. FROST..........................BUSINESS MANAGER

Chicago Office: Monadnock Building.
F. A. PECKHAM ....MANAGER

EUROPEAN AGENCIES.

KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng
SAMPSON LOW, MARSTON & Co (Limited). St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50: 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested

ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The Engineering News Publishing Co. offers the following premiums for the best graduating theses presented by students graduating in 1894 from any engineering course of any college in the United States or Canada:

Open to graduates from the regular course of four years or less only; third annual offer:

For the best graduating theses (under the conditions below stated), First Premium, $75; Second Premium, $50; Third Premium, $25.

For such other theses as may seem to deserve such recognition, Honorable Mention, accompanied in each case by two years' paid subscription to Engineering News.

A Special Premium of $100, open both to post-graduates and undergraduates, is also offered. All theses submitted by undergraduates will be considered as in competition for this premium without special entry.

The conditions of the competition will be as follows:

1. Competing theses must be sent in by the college authorities, not by the authors. They must be sent in anonymously, both as to author and college, indorsed on the outside, "For Engineering News Thesis Competition," and addressed in care of the Secretary of the American Society of Civil Engineers, 127 East Twenty-third St., New York, who has kindly consented to receive and open the packages. They must be accompanied by a sealed envelope indorsed on the outside with the title of the thesis, and containing within the name, address and college of the author and a certificate from some one of his professors to the effect that the thesis has been examined and is indorsed as in all known respects worthy of entering such a competition. These sealed envelopes will be retained and opened by the Secretary after the announcement of the awards has been made to him. (It is particularly requested that all marks or words giving any clue to the origin of the thesis be erased, so far as possible.)

2. Theses sent in by post-graduates must have the word "Post-graduate" conspicuously and permanently attached to the manuscript.

3. The examinations and awards will be made by the editors and associate editors of Engineering News, assisted by such experts in the several branches of engineering as they may select to aid them in reaching a just decision.

4. The basis of selection for premiums will be the same as that used in selecting papers for publication in engineering journals or society proceedings; that is to say, theses will be graded according to their apparent permanent value for the advancement of engineering practice or theory, either as records of original research or as intelligent and concise discussions or critical summaries of older researches. Clearness, conciseness and care in summarizing conclusions will be essential merits for a high award.

5. The right is reserved of withholding any or all premiums, in case no theses of sufficient absolute merit to deserve them shall be received. No thesis not deemed worthy of publication in full in Engineering News will be awarded any premium.

6. Except for special reason stated in the professors' certificates above referred to, not more than three of the graduating theses of any one college shall be entered for the competition.

7. The right of first publication of all theses awarded premiums or honorable mention is reserved to Engineering News, and all theses receiving premiums will be so published.

8. No thesis which has been previously published in full or in substance will be eligible for the competition; nor any in which due credit is omitted for any part of the thesis not original or for work recorded therein not performed under the author's direction—excepting such facts as are of common knowledge and record.

9. All theses competing for these prizes should be sent in on or before Aug. 1, to insure consideration though this date will not be rigidly insisted on.

10. The awards will be announced on or before Nov. 1, 1894, failing some special cause for further delay. All theses receiving neither premium nor mention will be returned by express to their authors. The manuscripts of the selected theses will belong to Engineering News, but the drawings will be returned after publication.

Circulars containing the above announcement have been mailed to the "Department of Engineering" of every college having such a department of which we have the address. If by any chance any college should fail to receive them, it will confer a great favor upon us by advising us of that fact and copies of the circular will at once be sent to it, and also to any other person asking for them on request.

◆

The value of the cotton shipped from the United States in the last fiscal year amounted to the very important sum of $182,000,000. But, unless, says U. S. Consul Monaghan, of Chemnitz, much more attention is paid in the future to foreign requirements and the shipping practice of competing nations, there is likely to be a serious curtailment in the foreign demand for the American staple and corresponding danger to this important American industry. Mr. Monaghan gives with his report three photographs of cotton bales as received at Chemintz from America, India and Egypt. The two latter appear in compact, well covered, well marked and unbroken packages, practically proof against all injury by water, fire, dust, or waste in transit. The sample from the United States, on the other hand, has four out of its eight iron bands broken or loosened; the flimsy jute covering is torn in every direction and the cotton has swollen out to at least twice its original bulk with the material exposed to all the contingencies named above, conditions which mean loss and test of temper on the part of the receiver. In addition to the use of poor covering and badly secured or weak banding, the American shipper does not compress his cotton as tightly as does either the Indian or the Egyptian. For example, the American bale of 475 lbs. occupies 22 cu. ft., while the Indian bale of 400 lbs. occupies 10 cu. ft. and the Egyptian bale of 700 lbs. only 15 cu. ft. When a cubic yard of space in a ship's hold costs from $3 to $5 for ocean freight, space occupied becomes an important consideration, and economy in this direction holds in land transportation as well. This is more easily understood when we say that a ship that can carry 16,000 to 18,000 bales of Indian cotton will hold only from 6,000 to 10,000 American bales.

As the political party now in power loudly advocates the opening of the markets of the world to the producers and manufacturers of the United States, by removing existing tariff restrictions, the report of Consul Monaghan should serve as a warning and a guide in any policy of foreign trade. No one can blame the foreign buyer for preferring that material which comes to him in the shape best adapted to his use, and the shipper from any market who fails to recognize this preference will deservedly suffer loss of trade. Caution is necessary not only in the methods of packing raw materials, but also in the adaptation of the form of manufactured articles to foreign practice and prejudices. A thing that will suit the consumer or user in the United States may not at all fit the requirements of another people, and these requirements must be carefully studied. The question of the dimensions of machinery and standard fittings of all kinds comes in here, and the wise maker for foreign markets, especially among the Latin races, will early recognize the fact that the metrical system prevails in most foreign markets and the fitting or engine so dimensioned will be preferred to another made according to what is to them a foreign and unfamiliar standard. Several important English manufacturers are now changing their patterns to conform to metrical standards, and find the task is not so serious in its proportions as was generally supposed. We doubt not but that the people of this country would soon accommodate themselves to any changed relations in foreign trade; but that some closer study of both old and new conditions and requirements is necessary is evident by the report of Consul Monaghan quoted above.

◆

We publish in this and our preceding issue what is not only the most important paper on the use of belting that has ever been published in this journal, but what may fairly be said to be the most important that has been published anywhere, so far as we are able to find.* Rules for proportioning belting are legion, but they vary between such wide limits that the engineer of experience generally has a rule of his own, and the inexperienced one may well be at a loss as to what to decide upon.

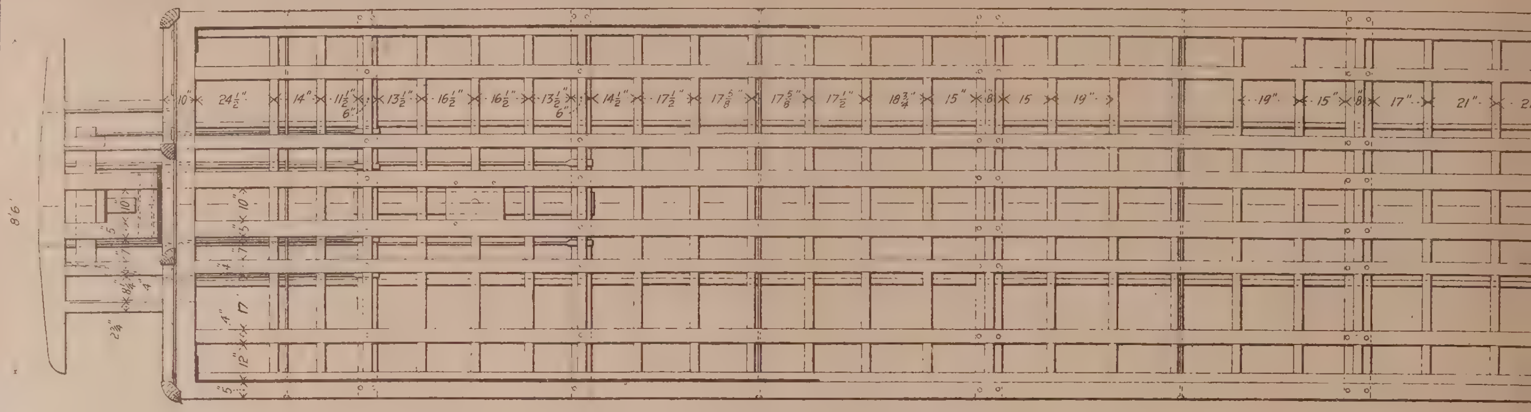
The rules proposed by Mr. Taylor in another column are based on a more extended and more intelligently conducted service test than has before put on record, so far as we recall. They are certainly deserving of careful study by engineers, and should have received more extended and intelligent discussion than was had at the Mechanical Engineers' meeting last week. The general purport of Mr. Taylor's experience is that where a belt is to be run steadily year in and year out, it pays to work it under a much smaller total load than is generally adopted. In other words, by using a larger belt to transmit a given power, the belt has much longer life, costs far less to keep in good order, and, more important than anything else, it works steadily, year in and year out, without causing delays and stoppages of machines.

Of course the first cost is greater when an establishment is equipped with pulleys and belting on the basis recommended by Mr. Taylor than where the belts are worked harder; but it is well to have it pointed out that where belting is to be steadily used until worn out it is an error to scrimp the sizes of the belts and run them at the high speeds which are adopted in country sawmills. On the other hand, where belts are to be used in temporary plants, or on machinery running but a part of the year, or only a few hours per day, then it would be entirely correct to work belts up much closer to their slipping point.

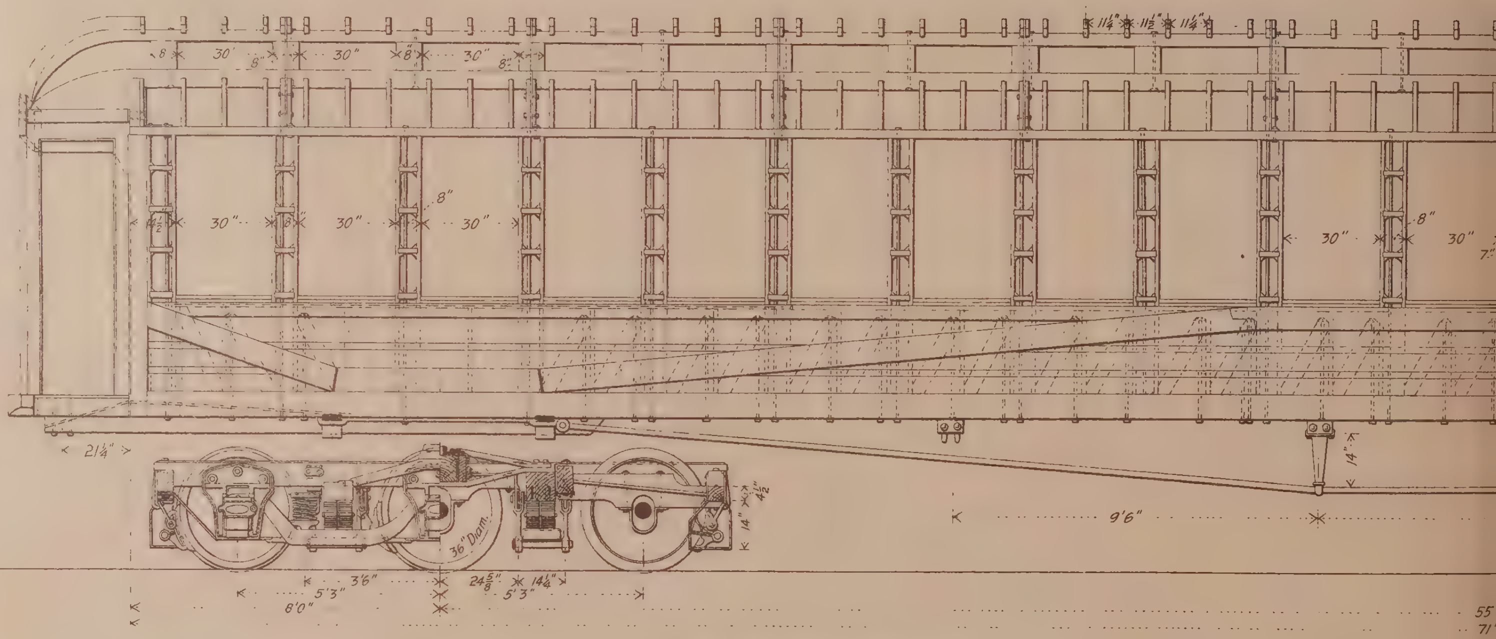
The use of belting for transmitting large powers in dynamo driving has become so important of recent years that rules for its proportioning are of much interest. It is to be hoped that a comparison may be made between Mr. Taylor's rules and those in use for dynamo driving by some engineers experienced in the latter.

---

* The best articles on belting which most engineers will find available are by Prof. Horace B. Gale, "Journal Assoc. Eng. Soc.," Vol. VII., p. 429, and in the "Transactions of the American Society of Mechanical Engineers," Vol. II., pp. 91, 224; Vol. VII., pp. 347 and 549; Vol. VIII., p. 529; Vol. X., p. 765.

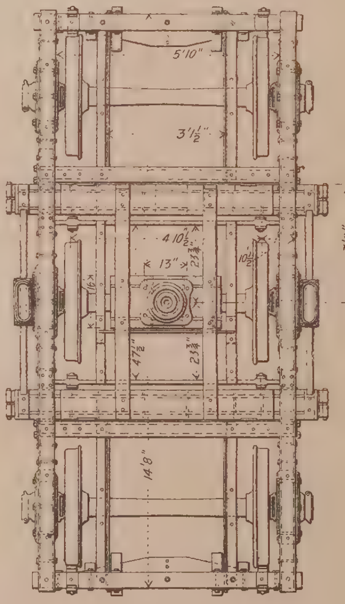


Half Plan of Frame of Passenger Car.

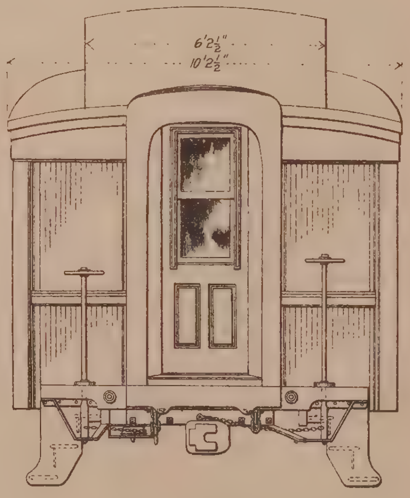


Half Side Elevation of Body Frame.

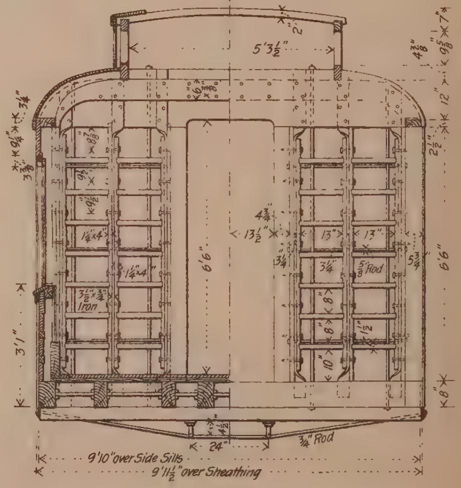
PASSENG



Plan of Truck.



End Elevation.



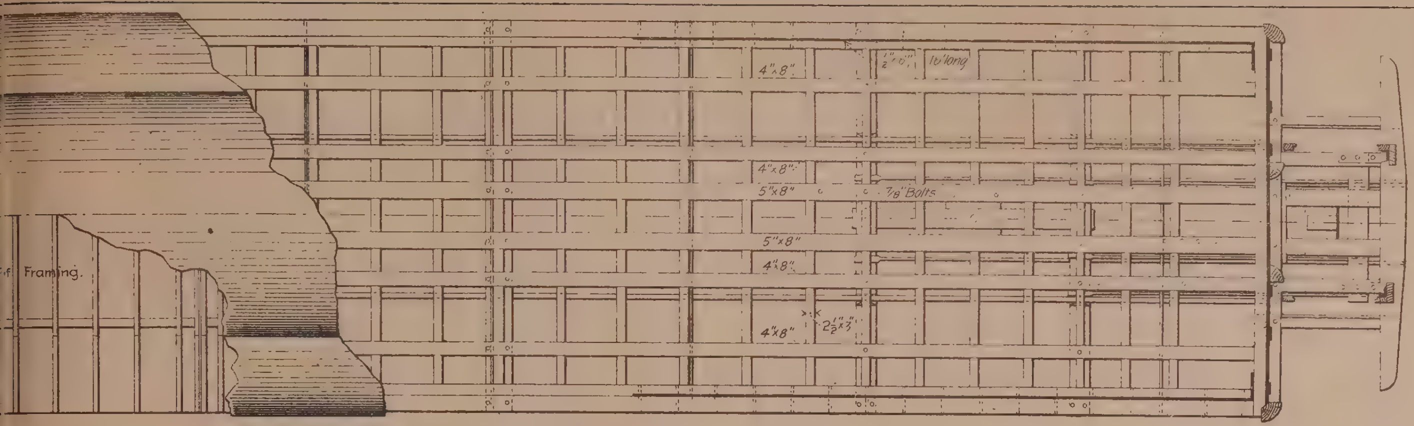
Half Section through Center of Frame.

Half End Elevation of Frame.

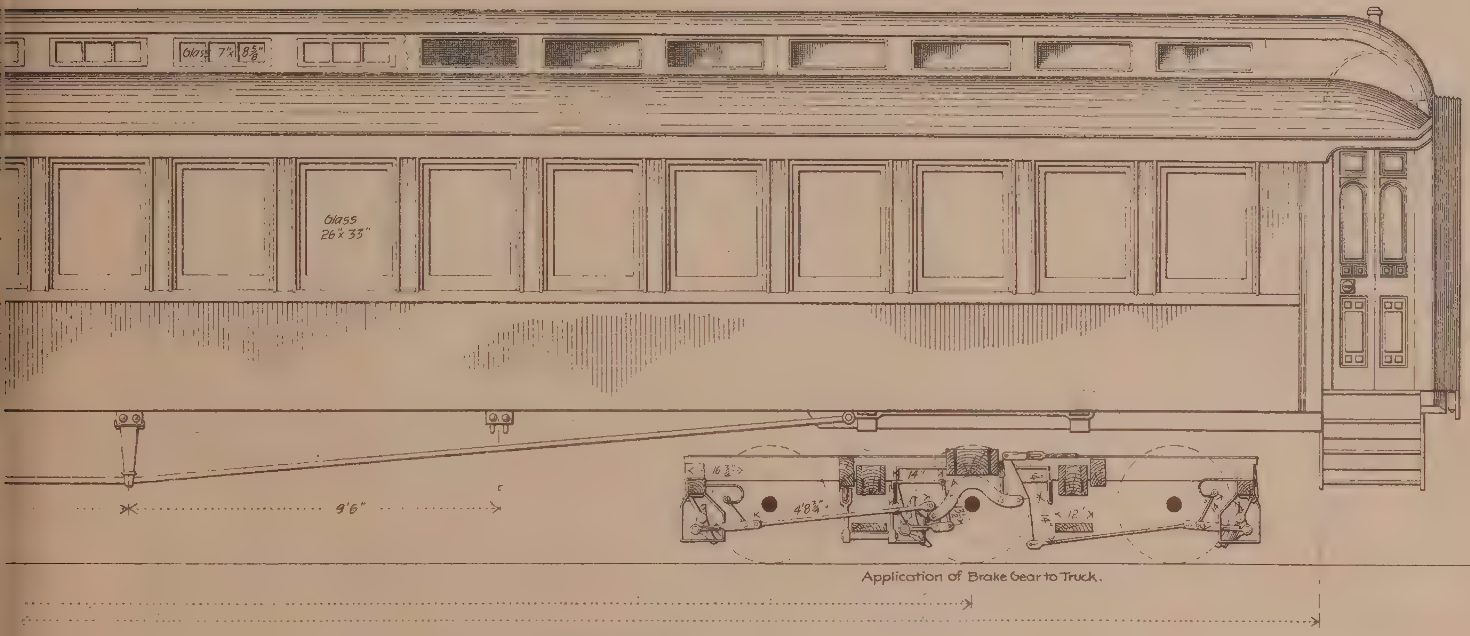
PASSENGER CAR AND COMBINATION CAR;

Exhibited at the Worl

William Buchanan, Superintenden

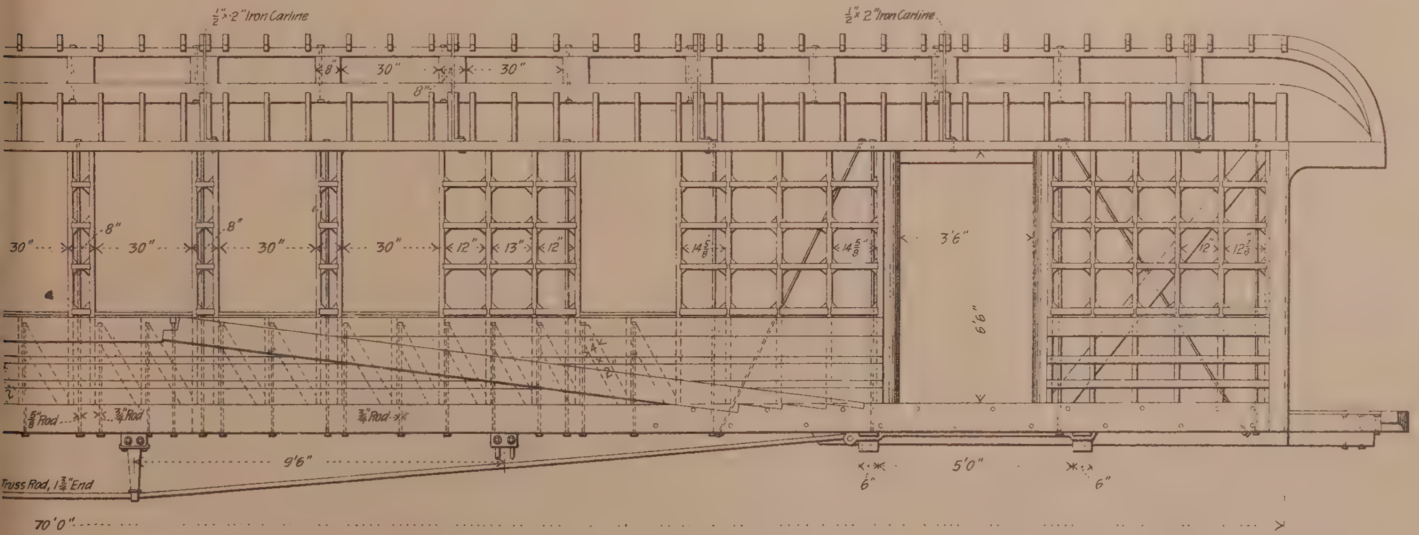


Half Plan of Frame of Baggage, Buffet and Smoking Car.



Application of Brake Gear to Truck.

Half Side Elevation.



Half Side Elevation of Body Frame (Baggage Compartment.)

BAGGAGE, BUFFET AND SMOKING CAR.

YORK CENTRAL & HUDSON RIVER R. R.

mbian Exposition.

tive Power and Rolling Stock.

CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

TESTING CEMENT BY FLEXURE.

The article on the testing of cement by flexure printed in another part of this issue is, in our estimation, one of unusual practical value to engineers. Our opinion of this paper, considered purely and simply from the standpoint of its origin and purpose—as an example of college students' thesis work—has already been expressed by awarding it the first place in our prize list in competition with 15 other theses, several of which were of a high degree of excellence, not only as theses, but as contributions to engineering literature. But it is in the practical value of the investigations, irrespective of any consideration of its origin, that the paper is chiefly worthy of regard, and from this point of view, laying aside all other considerations, it is proposed to discuss here some of its more salient features, and especially the main question which it broaches, the comparative advantages of tensile and transverse tests for cement.

During the last 20 years great advance has been made in our knowledge of the character and uses of hydraulic cement. European nations have been especially active in making investigations through numerous conferences of engineers and manufacturers, and by elaborate experiments conducted in their various laboratories devoted to the study of this one material. While the exceeding great value to the special student of cements of the work done by the Service des Ponts et Chaussees, and the Military Engineers in France, and by the laboratory at Zurich, in Switzerland, and those at Charlottenburg and St. Petersburg in Germany and Russia, cannot be denied, it also cannot be denied that the most essential purpose of this work, viz., to furnish the practicing engineer a simple and sure means of estimating the character of the product he is employing, has too much been lost sight of. In other words, the tendency of laboratory workers, with their attention continuously fixed upon tests, to study them for their own sake and to introduce complexities and refinements impossible to practicing engineers, works to restrict rather than to increase the use of such tests. Every step increasing the complexity of a test is a much longer step decreasing the extent to which that test will be used in practice.

Touching upon some of the points mentioned above, Prof. H. Le Chatelier, of the Ecole des Mines, Paris, says in a recent article:

> Cement tests have a purely practical purpose, that of recognizing by a simple and rapid process the presence in a given commercial product of the qualities which previously laboratory researches have shown to be useful and the absence of properties similarly shown to be harmful. They can be carried out by simple manipulations, apart from all scientific knowledge, and require only fidelity and some manual skill. . . . It is prudent not to repose in these tests too great confidence, and it is on this account useless to conduct them with a minute accuracy they do not deserve.

These three short sentences embody every principle which should underlie the formulation of any method for testing cement intended for the use of the practicing engineer.

Generally speaking, not more than four different kinds of tests are necessary to give the engineer all the facts he desires for a very true knowledge of the material he is about to use. These consist of what may be termed three physical tests to determine: (1) The fineness of grinding; (2) the time required for setting; (3) the soundness or freedom from blowing; and one mechanical test to determine (4) the strength against rupture. Of these four tests the last is, perhaps, the only one never neglected under any conditions of use, when any test at all is made, and it is this mechanical test for rupture that is discussed in the article printed elsewhere. By testing cement for rupture is commonly meant rupture by tension or compression. Tests for rupture by flexure are seldom made, and tests for rupture by shear or torsion practically never made. In actual practice this fourth test is still further limited, since the tensile test is almost universally used, while the compressive test is the exception.

This preference shown for the tensile test, which does not at first at least appear the most rational, naturally raises the question as to whether it is well founded or not. It seems pretty certain that this was not chronologically the first form of testing cement, although probably the form which has been most extensively used from the first. The greater cost and difficulty of securing perfectly adjusted and accurate machines for compressive tests in the early days of testing probably explains its rejection for tensile tests, and a similar reason would probably reject the shearing test. These reasons do not hold good for the rejection of the bending test, however. If we examine the tensile test for its greater inherent adaptability for showing the qualities most required in cement in ordinary engineering structures, we must admit that a simple tensile stress is less likely to act than either compression, flexure or shear. About the only satisfactory explanation is that tests by tension having once been begun, precedent, the desirability of having results of previous tests with which to compare those of each succeeding test, and the fact that, excepting flexure, tension is the most simple test for rupture in such a material as cement, have worked together to continue the method.

The desirability of having a basis of previous experimental results for comparison is a valid reason for holding to the present tensile test, and about the only one of much moment, yet it must be remembered that this is but an empirical basis furnished by experiments upon a material which is especially sensitive to even small variations in the methods of conducting the tests. Tests by flexure, it must be admitted, lack such a basis of comparison to a great extent, although a good start has been made by the experiments which we publish. In the respect of cheapness, simplicity, rapidity, ease of manipulation, and adaptability to discover every point capable of determination by a rupture test it is the superior of the tensile tests. In the matter of precision both tensile and bending tests are, of course, subject to errors of machinery, the bending tests less than the tensile, and to errors due to variations in applying the stress, gaging, molding, etc., but in addition to these the nature of the stresses is such that the preponderant influence which the superficial parts of a cement briquette have upon its strength is emphasized, and thus any imperfection due to molding or external conditions tending to produce alteration in these superficial parts is emphasized.

This influence of the superficial parts has been observed in the bending tests given elsewhere and briefly commented upon in the paper. It is well known to seriously affect the precision of the results in tensile tests, and is in no sense an ultra refinement which may be neglected in accounting for irregular results. As to the comparative effect of this peculiarity upon the precision of tests made by flexure and tension it is not easy to say, but there seems reason to believe that it would not be less with flexure than tension. In this particular at least a compressive test has advantages over either tension or flexure, and could it be as simply made would be a more rational test than either of the others.

But as to the comparative advantages of flexure or tension in testing cement, it appears to us that there should be little question; the bending test is preferable in every respect. It is needless to multiply reasons further, as the authors of the paper referred to have already touched upon most of them, and, besides, they are self-evident to any one who remembers that a knowledge of the tensile strength of a 1-in. square briquette of cement is of no value except for comparison with a certain number which previous tensile tests have shown to the general average strength of 1-in. square briquettes against tension.

Turning now to some of the other points brought out by the paper, it will be noticed that the "common theory" of flexure does not hold good in calculating the tensile strength from the strength of flexure, that in fact the actual strength of a prism broken with a 4-in. span is about twice the theoretical as ordinarily computed. Of course it is well known that the tensile strength determined by experiment does differ from that calculated by the "common theory" formula, and also why this is so, for the formula is only true up to the point of elastic limit. Nevertheless it seems never to have occurred to any of those who have made former transverse tests, and it has been left to the authors of this paper to first demonstrate the serious errors involved in all calculations of the tensile strength of cement from the strength of flexure by the "common theory." Another point of practical interest is that the rate of applying the load between reasonable limits does not materially affect the breaking strength. Other facts brought out by the experiments have already been mentioned or are sufficiently noted in the paper. These are all of interest and pertinent to the question which has been chiefly discussed here. We think that a fair study of them will lead to the conclusion that for a constructing engineer's test the bending test is much superior in all important respects to the tensile test and deserves attentive consideration by engineers.

LETTERS TO THE EDITOR.

EXPERIMENTS ON THE MECHANICS OF FLIGHT.

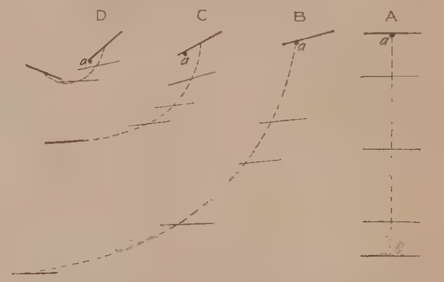
Sir: I have read with much interest Mr. Wellington's paper on the "Mechanics of Flight and Aspiration" and your editorial remarks thereon (Engineering News, Oct. 12, 1893). As experiments I have recently made lead me to exactly the same conclusion as his, in that no power whatever beyond the weight of the flying body (and a skillful use of the wind) is required for flight, I think a short account of my method of proving the above may be of interest.

I tried the following experiments: Dropping a small weighted plane, weight fixed at "a" in the cut below, in which the dotted lines show trajectories, and the thick lines, positions of planes at different moments. I obtained the following results:

Case A.—In this case the trajectory of the plane is vertical; the maximum velocity = V can easily be found as explained in Weisbach's Mechanics of Engineering, Vol. I., p. 1031, etc. It should be noted that almost the maximum velocity is attained very quickly, so that the motion is practically uniform. Hence, the energy stored in the plane when it reaches Q, or any point shortly after starting

$$\frac{W}{2g} V^2,$$

and this energy is being directed vertically downward.



Case B.—In this case weight a is moved forward and the plane describes a parabolic path approximately, its inclination to the horizon decreasing until the lowest point of the curve is reached, when it = 0°. The energy is again as above, because the only alteration that has been made has been to alter the direction of action of the energy. This energy can now be used horizontally. It is obvious from inspection of the curve that the plane has a horizontal and constantly increasing velocity, say, v, v′, v″. . . . V, as well as a vertical velocity.

Cases C and D.—Just the same thing happens in these cases, but V is more quickly attained.

The points to which particular attention should be drawn are:

I. In Case A there is the amount of energy shown in the above formula, being used in a vertical direction.

2. In Cases B, C, D, there is the same amount of energy, but it can now be used in a horizontal direction.

3. This change has been produced by the weight, which has been so moved as to give a propelling horizontal force supplying velocities v, v′, v″ . . . V, as well as a vertical one.

4. The plane has, without any force but its own weight, attained a horizontal velocity = V, although its original horizontal velocity = 0.

Next take the case when the plane starts with a horizontal velocity of, say, 50 ft. per second, with the weight adjusted as at B. It is obvious that the resultant motion must be a continuation of the 50 ft. per second horizontal velocity path, and the trajectory shown at B. In other words, the total horizontal velocities will be 50 + v1, 50 + v2, 50 + v3 . . . . 50 + V, so that the energy at the lowest point will be:

$$\frac{W}{2g}(50 + V)^2$$

Of course, if a plane adjusted as in Case A was moved at 50 ft. per second horizontally, its path would lie between the 50 ft. per second path and the trajectory A, and the horizontal velocity at any instant would never be more than 50 ft. per second, as v, v', v'' . . . . would all be = 0.

5. It should be noticed that by increasing the weight carried per square foot V can be made any value required, and, theoretically speaking, an almost infinite amount of energy can be got without any expenditure of power except that required to move the guiding weight a.

6. With the rest of your remarks about circling, etc., I quite agree, but the main point to show is, how the energy can be obtained without the expenditure of power.

I have not, of course, dealt with any of the questions of equilibrium. I am, sir, yours truly,

J. D. Fullerton, Major R. E.

The Barracks, Chittenden, Rochester, Eng., Oct. 30, 1893.

(Our correspondent's experiments show admirably how energy may be converted into horizontal velocity even in still air, and how a very small amount of energy from gravity or elsewhere may be readily converted into a very great amount of horizontal propulsion. In one respect only his argument seems to need some emendation and addition. Energy, of course, is a real thing, as much so as money. We cannot get more money than we already have in our pocket unless we have some outside source of supply, and in like manner we cannot get more energy into a body than it already has stored in it unless we have some outside source to get it from. A soaring bird which is already high in air has a store of potential energy because of that fact on which it can draw at will until it is exhausted; but never so as to lift it by however little above where it started from, or even quite so high, because of its continuous slight loss from friction. Therefore, when we see a soaring bird performing any maneuvers it desires without muscular effort, and rising up or down as it pleases, we know it must take its continuing supply of energy from the wind, because that is the only body endowed with energy to surrender with which it has any contact. Hence we should conclude on a priori grounds alone that continued soaring flight was an impossibility in still air, and finding this to be so in nature not only is this conclusively confirmed, but it is practically established that soaring birds do take their continuing supply of energy from the moving air, and the only remaining problem is, how they do it. We have only to extend our correspondent's general line of reasoning by assuming a horizontal force to be continuously acting so as to extend still further the horizontal component of the path of the falling bird, thus modifying by external force its otherwise natural path of descent, and we have this problem also solved. All else follows simply enough in a mere dynamic sense, but the problem of imitating the bird's power of maintaining equilibrium by unconscious reflex nervous action still remains.—Ed.)

"AMERICAN" ENGINEERING SCHOOLS.

Sir: In your issue of Nov. 30 I notice a very silly letter from a Canadian protesting against calling McGill University an "American" engineering school and a well merited rebuke from yourself. As a thoroughbred Canadian and a very old-time subscriber to Engineering News, will you allow me to voice the disgust which I know every sensible engineer in this country must feel when he reads this letter. The engineers of Canada, above all other professional men, must feel as I do, how far and away ahead the United States is of the rest of the world in almost every branch of the science and how much they are indebted to her.

I think that the only objection right thinking Canadians have to joining fortunes with the great republic is on account of the machine politics which the better class of Americans deplore, and that the name of Canada, which has stood on the map of the world for 300 years, would be wiped off forever.

Sincerely, Henry K. Wicksteed.

Cobourg, Ont., Dec. 2, 1893.

(The letter referred to was probably recognized as a mere individual outburst of misdirected local patriotism, and as such only was published. The political issues referred to we cannot discuss, beyond saying that good Americans "deplore" anything short of perfection in their political or other affairs, but they are not conscious of admitting thereby any such extreme imperfections as our correspondent's invited comparison would in their eyes imply. The difference of opinion on that head which our correspondent might develop by a little inquiry would, perhaps, surprise him.—Ed.)

TRANSITION CURVES.

Sir: I notice in a recent issue a letter calling attention to a paper by Mr. Muenscher in the "Annual of the Michigan Society of Civil Engineers, 1891-2," giving a practical method of running transition curves without any tables other than such simple ones as could be committed to memory. Kindly allow me to say that almost contemporaneously there was read before the Canadian Society a paper by the writer taking up precisely similar ones.

If the letter is of any value to the profession, as it certainly was in promoting discussion, if nothing else, it is a pleasure, as well as a duty, for me to acknowledge, as did Mr. Muenscher, that the unfinished series of papers in Engineering News, by Mr. Wellington, were what set me thinking, and that I merely carried on the investigation which he commenced in them.

Sincerely, Henry K. Wicksteed.

Cobourg, Ont., Dec. 2, 1893.

(Mr. Wellington desires to state that other and very engrossing demands upon his time, which he could not ignore, were the sole reason why he left that series of papers unfinished, and also the field-book, of which they were to be a part. Some day, when he has no such demands, he hopes to finish both.—Ed.)

THE PHILADELPHIA MOON SCHEDULE.

Sir: Will you be kind enough to explain what is meant by the "Philadelphia Moon Schedule," so often referred to in connection with municipal lighting? By that schedule what proportion of the nights of the year are to be exempted from artificial light?

Yours truly, A. Rogers.

Warren, Pa., Dec. 4, 1893.

(The following letter received by us from the Chief of the Philadelphia Bureau of Gas may answer the above, or it may be that the schedule in question is that devised and worked out in detail by Mr. Alex. C. Humphreys, General Superintendent of the United Gas Improvement Co., Drexel Building, Philadelphia.—Ed.)

Sir: Our public lamps are lighted all night and every night. This has been the rule for nearly 20 years, and the old rule provided for the lighting of lamps half an hour after sunset or before the setting of the moon and their extinguishment half an hour before sunrise or the rising of the moon. W. K. Park,

Chief of Bureau of Gas.

Philadelphia, Dec. 9, 1893.

ONTARIO PUMPING ENGINE—PERSONAL.

Sir: I notice in your issue of Nov. 2 a letter from Mr. Irving Reynolds, of the E. P. Allis Co., relative to deep mine pumping engines, in which he refers to me as the designer of the engine at the Ontario mine, Utah. I wish to say that I had nothing to do with the design, although the arrangement of cylinders and beam was made in accordance with my patents, being the same as I had previously used on various pumping engines. The engine was designed by Mr. Wm. R. Eckart, of San Francisco, and built by the I. P. Morris Co., of Philadelphia, and reflects great credit on both the designer and the builders.

Yours truly, E. D. Leavitt.

Cambridgeport, Mass., Dec. 5, 1893.

THE AM. SOC. C. E. ELECTION—A CARD FROM MR. FRANCIS COLLINGWOOD.

Sir: I respectfully request you to give prominence to the following personal explanation: I decided at the outset not to oppose the action of the Nominating Committee in placing me in nomination for the vice-presidency of the American Society of Civil Engineers. Since that time I have been formally nominated as secretary by about 70 members from various parts of the country, and this, together with the most urgent solicitations of many friends, has led me to accept renomination to that office, which I did on the 5th inst.

The Board of Directors has decided that the constitution requires the official ballot to contain my name as a candidate for both the offices mentioned. I wish, therefore, to state in most positive terms that I am NOT now a candidate for the vice-presidency, and under the circumstances if by possibility I should be elected to that office I would feel it my duty to decline it.

It is my particular request that my friends shall refrain from unfavorable criticism of the opposing candidate, and that the contest shall be decided on the broad ground of policy.

F. Collingwood.

New York, Dec. 7, 1893.

(The chief purpose of this letter of Mr. Collingwood is to notify his friends that he is a candidate for secretary, and not for the position of vice-president, and to warn them to vote carefully. While we exceedingly regret the present contest, the majority of the membership will doubtless agree with us that the faithful and zealous services of Mr. Collingwood since 1891 were deserving of a much less summary disposal of his case than appears from the evidence before us. While the tenure of office is nominally for one year only, it is the universal practice in such societies to consider this office as one held during good behavior and usefulness, and this practice is justly held to be for the general good and progress of the society. The office itself debars the incumbent from engaging in outside engineering practice, and if there is any dissatisfaction with his services, common courtesy, if nothing else, should lead to a timely and sufficient warning of such dissatisfaction and provide an opportunity for the incumbent to regain professional ground necessarily lost while in office. The comparative merits of the candidates are not a question at issue with us; but in the interest of present and future incumbents of this important office, we greatly regret what seems to us the discourteous treatment of an admittedly faithful and zealous officer, and a man who personally is deserving of the respect and consideration of the members of the society. Where a change is deemed necessary it seems to us that the rule in all similar cases should be to give timely warning to the incumbent of dissatisfaction from any cause, so that he may answer any direct charges made; or resign by his own initiative; or, what amounts to the same thing, decline a renomination. This treatment would certainly be more just and courteous, and involves no possible sacrifice of a society's interests.

The circumstances which have called forth this nomination and this letter, as we understand them, were these: Mr. Collingwood was elected secretary in January, 1891. He has been a faithful and zealous officer by universal admission, devoting his entire time to the service of the society. While the tenure of office is nominally for one year only, it is the universal practice of all such societies to consider the office as really one to be held during good behavior and usefulness, as is obviously just, since the faithful discharge of the duties of the office takes a man out of the line of active practice, and even compels him to turn over to others opportunities which he is especially likely to hear of first, because of his office. In one recent instance which we chance to know of Mr. Collingwood did, in fact, turn over to others, a very desirable engagement which was formally tendered to him, and on which otherwise he would now be likely to be engaged.

This being the prior status, Mr. Collingwood finds on receiving the official nominations for the ensuing year that his assistant secretary, appointed by himself, has been nominated for secretary in his place, and that he is nominated instead for the merely honorary and unsalaried office of vice-president. No intimation or hint that such a move was in contemplation had reached him.

Under these circumstances, the view taken by a large number of members, to our knowledge, is that it is not just nor courteous treatment of a faithful officer to dismiss him thus curtly; that he is entitled to some prior notice, to some opportunity to be heard, to an opportunity to resign his office by his own initiative if he prefers that course. From this point of view, whether or not an incumbent is really the best man to fill the office permanently, whether or not a change is really expedient, is not the point at issue. No one can express a positive opinion on this head who is not intimately familiar with all the society's affairs; but any one can form an opinion as to what is a proper and improper manner of removing a faithful official from a supposedly permanent office if it is to be done at all, especially when the office has been held so short a time as to make his summary removal a marked slight. Without any reflection upon the regular candidate, who is, no doubt, a promising and capable officer, we think the general feeling of the society will be that there was no such urgency for a change that it should be made in this way, and with such an apparent lack of effort to do as little injury as possible to the feelings and the interests of all concerned. Were there any charge, or even the slighest suspicion, that Mr. Collingwood had been in any way remiss in the discharge of his duty to the society, the case might be different; but this, we are sure, is not the case.—Ed.)

NOTES AND QUERIES.

E. R., Saltville, Va., asks: Can you or some of your readers inform me as to the shortest radius to which straight lengths (12 ft.) of different sizes of cast iron pipe can be laid ?

London statistics of the great coal strike, just ended, figures the total loss to labor, producers and consumers, at $166,156,075. This divided as follows: Estimated loss to mine owners, iron masters, railways, etc., $66,278,075; extra cost to consumers, $8,825,000; loss to labor of miners, ironworkers and other artisans, $91,040,000. The idle workers numbered 1,003,250, or including those dependent upon them, 3,511,425. The strike lasted 16 weeks.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 247.)

Chemical Results from Intermittent Filtration at South Framingham, Marlborough and Gardner, Mass.

The degree of purification secured from the intermittent filtration of sewage at South Framingham, Marlborough and Gardner, Mass.,* may be judged from the many analyses of crude and filtered sewage given in the report of the Massachusetts State Board of Health for 1892 and summarized below. The period covered by the analyses was about 27 months for South Framingham, 16 months for Marlborough and 22 months for Gardner, and closed on July 26. The results as a whole are very good, showing a removal of 97.9% of the organic matter, as represented by the albuminoid ammonia, at South Framingham, 95.5% at Marlborough and 88.7% at Gardner. The fact that both in 1892 and 1893 crops were raised on the South Framingham filter beds adds to the interest and value of these results.

Averages of Chemical Analyses of Crude and Purified Sewage at South Framingham, Marlborough and Gardner, Mass., Made in 1891, 1892 and 1893.

(Parts per 100,000.)

Average Results at South Framingham, April 11, 1891, to July 26, 1893.

	No. of samples.	Color.	Residue on evaporation.	Ammonia		Chlorine.	Nitrogen as		Hardness.	Iron.	No. of samples.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Sewage	18	.49	60.97	1.6431	.3851	4.46	.0186	.0181	6.8	.1129	19
Effluent (1)*	15	.02	22.17	0.1923	.0085	3.07	.8437	.0052	4.9	.0085	15
Effluent (2)*	20	.03	20.19	0.1002	.0075	3.19	.7464	.0031	4.6	.0103	20
Effluent (av.)*	17.5	.03	21.18	0.1463	.0080	3.13	.7951	.0042	4.8	.0093	35
Per cent. removed**	..	92.6	65.2	90.4	97.9	30.0	+4,175	77.0	29.1	91.8	..

* Effluents (1) and (2) are from the mouths of an outlet of an east and west underdrain, respectively, and the average given is the average of the two.

Average Results at Marlborough, March 30, 1892, to July 26, 1893.

	No. of samples.	Color.	Residue on evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Hardness.	Iron.	No. of samples.
Sewage	23	.51	50.63	1.865	.4753	6.04	.1282	.0228	7.2	.2093	23
Effluent	43	.04	23.40	.395	.0214	4.67	.7652	.0285	7.1	.0110	43
Per cent. removed**	..	92.2	53.8	78.9	95.5	22.7	+479	+25.0	1.4	94.7	..

Average Results at Gardner, Oct. 3, 1891, to July 26, 1893.

	No. of samples.	Color.	Residue on evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Hardness.	Iron.	No. of samples.
Sewage	31	.57	28.63	1.6531	.4045	2.69	.0163	.0039	3.6	.0796	31
Effluent	33	.20	15.53	.5667	.0455	2.23	.5130	.0551	3.9	.0254	33
Per cent. removed**	..	65.0	45.7	65.7	88.7	17.1	+3,231	+1,313	+8.3	68.1	..

** In a few cases there are increases, which are indicated by the plus sign

The sewage is screened and pumped at South Framingham, which removes or breaks up some of the larger particles of solid matter, and at Marlborough and Gardner the sewage passes through separating tanks where a considerable amount of solid matter is deposited. A limited filtration area, an overfine sand and a low sewage temperature at Gardner tend to lower the results obtained there, while at Marlborough the large size of the beds and the fact that the sewage is discharged onto them at only one point, make necessary a rapid discharge of sewage and hence too great a rate of filtration.

The approximate average daily sewage flow, the area of the filter beds and the ordinary minimum winter temperature of the sewage are as follows for each town:

	Sewage, daily, 1892.	Filtration area, acres.	Winter temperat're of sewage, °F.
South Framingham	177,000	12.0**	48 to 50
Marlborough	425,000*	36.8	39 to 42
Gardner	125,000*	1.9	32 to 38

* Approximate. ** Some sewage put on land not laid out in beds.

The effective size of the sand composing the filter beds of the three towns is as follows:

	Effective size of sand grains, 10% finer than	
	Mm.	Ins.
South Framingham	.32 to .42	.013 to .017
Marlborough	.12 to .14	.005 to .006
Gardner	.10 to .24	.004 to .009

The averages of several analyses of both sewage and purified effluent are given in the accompanying table. The averages are taken from the report. The percentages of decrease or increase have been computed and added for convenience.

The decrease in the albuminoid ammonia has already been mentioned, and is in general accord with the other determinations in showing that the purification effected at the three towns is in the same order as their position in the table. The increase in nitrates indicates that a large amount of organic matter has been oxidized, or nitrified, and the increase in nitrites at Marlborough and Gardner that the nitrification process lacks much of completion, the whole process being first the change of albuminoid to free ammonia, then to nitrites and finally to nitrates.

The averages of both sewage and effluents are to be taken by the averages of a period, the original sewage in each sample not being of necessity identical, although most of the samples of both sewage and effluent at each town were taken on the same day.

The winter results at each town for 1892-3 compare very favorably with the averages for the whole period, as is shown by the following figures:

	P. c. decrease albumin'd amm'nia.		Winter samples taken	
	Whole period.	Winter 1892-3.	No.	Dates.
S. Framingham	97.9	95.9	3	Jan 18, Feb. 14, 28.
Marlbor'gh.	95.5	93.3	4*	Dec 20, Jan. 26, Feb. 15, 27.
Gardner	88.7	84.4	6	Dec. 12, 21, Jan. 16, 25, Feb. 6, 27.

* Samples were taken on four days, but on three of these days duplicate samples of the effluent were taken and are included in the computations.

Not all the winter sewage at Gardner passed through the filter beds, owing to the fact that some of the beds were frozen a part of the time. At Marlborough and South Framingham, also, purification for the whole winter may have been poorer than the above figures indicate. But the effluent represented above passed through the beds and shows what can be done in a very severe winter, for the average temperature of December, January and February, 1892-3, was 22.5° F., 5.2° lower than the average temperature of these months for the ten years 1883-4 to 1892-3, inclusive, while the January temperature was 16.4°, 8.4° lower than the average for the same period. The advantage of an ample area was well shown at Marlborough and the disadvantage of a small one equally well shown at Gardner, for in the latter case the plant was to a large extent disabled for a time, while in the former the ample area allowed some of the beds to remain frozen and unused.

Each of these plants was constructed to prevent a nuisance and not to render sewage fit for drinking. The amount of organic matter annually diverted by them from running streams and rendered harmless is so great as to render of small moment the occasional discharge of crude sewage into the streams, provided water supplies for man or beast are not thus contaminated, of which there appears to be no danger, so far as is shown by the information at hand.

---

* See Eng. News, Aug. 11 and 25, 1892, for full illustrated descriptions of the plants at South Framingham and Marlborough, and Feb. 16, 1893, for that of Gardner. In our issues of Feb. 23 and March 16, 1893, an account was given of the effect of snow and ice upon the South Framingham filter beds, which is of interest in this connection.

RULES FOR THE USE OF BELTING.*

(Concluded from p. 450.)

In studying the results of the experiments, the most interesting and important fact noticeable is the superiority of the shifting to the cone belts in every respect except first cost, and this superiority is even much greater than the figures would indicate, since, generally speaking, the cone belts which are still in use are nearly worn out, having reached a point at which it is doubtful whether it pays to repair them, while the shifting belts are, to all appearances, in almost as good condition as when they first went into use, and should last twice as long as they have already. I think it would be safe to say that the life of the shifting belts will be three times that of the cone, and already the total cost of the shifting belts per year of service is less than that of the cone.

A comparison of the first cost of the belts is scarcely fair to the shifting belts, since, owing to the location of the machines, the cone belts are only two-thirds as long as their competitors.

It is interesting to note that after 8.8 years of life the total cost of maintenance and repairs of the shifting belts amounts to only 30.4% of the original cost, while with the cone belts the maintenance and repairs through a life of 6.7 years amount to 1½ times the firts cost.

In the writer's judgment, by far the greatest point of advantage of the shifting belts lies in the fact that the interruptions to manufacture are nearly seven times as frequent with the cone as with the shifting belts, each shifting belt having been tightened or repaired on an average only 6.6 times during nine years, while the cone belts averaged 32 interruptions to manufacture in 6.7 years; the shifting belts having run on an average 22 months without tightening, while the cone belts ran only 2½ months.

In ordinary shop practice, belts are tightened and repaired during working hours, and usually by the man who runs the machine which they drive; so that we are not far out of the way in considering the interruption to manufacture as about equal to the number of times each belt was repaired or tightened. When we remember, therefore, that these belts were watched with unusual care, and treated in what the writer believes to be the best known manner to secure durability, it seems safe to say that the interruptions to manufacture in the average shop or mill would be far greater than here recorded.

In the writer's judgment, by far the most important matter to be determined from the above table is the reason why the shifting belts have proved themselves so much more satisfactory than the cone, and with this end in view it may be well to recapitulate the various elements which chiefly affect the life and satisfactory running of belting. They were, he believes, as follows:

(1) The material from which the belts are made and the method of their construction.

(2) The means of fastening and tightening them on the pulleys; i. e., whether laced, spliced or fastened with hooks.

(3) The care and regularity with which they are greased, and whether they are kept clean and free from machinery oil.

(4) The general nature of the service which the belts are called upon to perform.

(5) Whether the belts run vertically or horizontally.

(6) The relative length of the belts.

(7) The relative speed.

(8) The tension under which they were tightened.

(9) The average total load to which they are subjected while working.

Since the "shifting" and "cone" belts were made by the same makers and of the same materials, and were spliced on the pulleys and greased and treated in exactly the same way, we need not consider the first three elements as given above.

As to the fourth—"the general nature of the service of the belts"—I think that to be used on either tight and loose pulleys or cone pulleys is about as severe a duty as belts are called upon to perform. It would be difficult to say, however, which of the two duties is the harder on belting, so that I do not think that we can look here for an answer to the question.

Undoubtedly horizontal belts will run under a lower tension than vertical, and in this respect the service of the cone belts was rather more severe than that of the others.

It will be remembered, however, that when the machines were moved from the old shop to the new one in which this experiment was made, the tight and loose pulleys on the countershafts were all thrown away and far larger ones substituted for them. This was done because the shifting belts in the old shop were such a great source of trouble. They were there run under the same "total load" as the cone belts, and owing to their inaccessibility, undoubtedly wasted more time than the others. It would appear, therefore, that the direction in which the belts run does not seriously affect their durability.

---

* Arranged from a paper by Fred W. Taylor, read at the New York meeting of the American Society of Mechanical Engineers.

In the sixth element—"the length of the belts"—the shifting belts unquestionably have an advantage, since they are one-half longer than the cone belts; and it is safe to say that (other things being equal) the life of the belt should be greater as the belt increases in length, up to, say, 50 ft. The small difference in the length of the belts, however, would not at all account for the great superiority of the shifting belts, and this advantage, it would seem, must be much more than overbalanced by the fact that the shifting belts ran about twice as fast as the cone belts, and were always running when the main line of shafting was moving. The fact that the shifting belts ran about twice as fast as the cone belts, and yet lasted so much longer and worked in every way so much more satisfactorily, shows that the relative speed of belts (at moderate speeds at any rate) has but little effect on their durability.

It is, however, without doubt in elements 8 and 9 that we find the answer to our question, for while the two classes of belts were repeatedly tightened to the same initial tension, 71 lbs. per in. of width, or 239 lbs. per sq. in. section, the shifting belts were, owing to their greater speed and width, subjected to a far lighter total load than their competitors, and to this fact their great superiority over the cone belts is undoubtedly due.

The good effects of the lower "total load" to which the shifting belts were subjected can be clearly traced through several items in the table. The most important of these would seem to be the item which shows the tension to which the belts had fallen when they required tightening. The averages in this item (for the cone belts especially) show the exact point in the tension of the belts at which they were just able to do the work required of them, and it will be remembered that this point was in no way arbitrarily determined, but was fixed by each belt for itself by giving indications that it was about to slip seriously. It should be noted that in the case of the shifting belts they rarely, if ever, slipped. They were taken up, in almost every case, because they had stretched so much that they began to flop and jump about to such an extent as to be in danger of damaging themselves.

We note that it only took 2½ months for the cone belts to fall from the initial tension of 71 lbs. per sq. in. of width to 33 lbs., their slipping point, while the shifting belts were 22 months in falling from 71 lbs. to a tension of 21 lbs.; and undoubtedly, if the cone belts had been subjected to as light a total load as their competitors, they would have run equally long without requiring to be tightened. Another good effect of the light "total load" on the shifting belts is seen in the fact that they stretched 0.81% before having to be tightened, while the cone belts, which were subject to twice as great a total load, required tightening after they had stretched only 0.47%.

From the results of these experiments the acthor compiled the following schedule of rules for the proportioning of belting:

Driving Power.—A double belt, having an arc of contact of 180°, will give an effective pull on the face of a pulley per inch of width of belt of 35 lbs. for an oak-tanned and fulled leather belt, or 30 lbs. for other types of leather belts, or six to seven-ply rubber belts.

The number of square feet of double belt passing around a pulley per minute required to transmit 1 HP. is 80 sq. ft. for first class of belts above named, and 90 sq. ft. for second class above named.

The number of lineal feet of double belting 1 in. wide passing around a pulley per minute required to transmit 1 HP. is 950 ft. for first class of belts above named and 1,100 ft. for second class above named.

A double belt 6 ins. wide running 4,000 to 4,500 ft. per minute will transmit 30 HP. for first class of belts above named, 25 HP. for second class above named.

Speed.—The belt speed for maximum economy should be from 4,000 to 4,500 ft. per minute.

The writer has recently had an interesting opportunity of comparing the ordinary rules for belting with the above rules. For three years past he has been engaged as general manager of a company in building and organizing two large sulphite pulp mills, in which about 3,500 HP. is transmitted by belting, this power being transmitted in units varying from 1,000 HP. to a belt down to a few horse power per belt. The shafting runs night and day throughout the week, from Sunday to Sunday, without a shut-down. Through a misunderstanding, during the absence of the writer at one of the mills, one-half of the other mill, aggregating about 900 HP., was belted under the following rule, which is believed to be about an average of the ordinary belting practice:

> A double leather belt, or six to seven ply rubber belt, will transmit 65 lbs. pull per in. of width to the rim of the pulley.
>
> The speed of the belting should be from 5,000 to 6,000 ft. per minute.

About one-third of the belting in the mill was leather and two-thirds rubber. On the return of the writer to the mill the second half of the mill was belted on the basis of 30 lbs. pull per in. of width of double belt transmitted to the pulley and a belt speed of 4,000 to 4,500 ft. per minute.

It is safe to say that the belting of the first half of this mill (ordinary rule) gave one hundred times as much trouble as that of the second half. In fact, the belting proved to be the chief source of trouble and expense in running the first half of the mill, owing to the frequent interruptions to manufacture caused by it, while that of the second half ran from the start with almost no trouble. This has proved to be a most emphatic though expensive confirmation of the results of the nine years' experiment above described.

Regarding the speed of belting, we see that, at moderate speeds, surely the speed of the belting has little or no effect on its durability, since the shifting belts, which lasted so much longer than the cone belts, ran about twice as fast. When the speed, however, becomes sufficiently high for the centrifugal force in rounding the pulleys to play an important part in increasing the "total load" of the belt, it becomes a most important element affecting the life of the belting.

The writer has adopted a speed of from 4,000 to 4,500 ft. per minute as the most economical belt speed for several reasons, one of which is that belting running above this speed has a great tendency to run in waves on the slack side and flop about and oscillate from side to side of the pulleys and so cause rapid wear, this tendency being greater and more dangerous as the width of the belt with relation to its thickness increases. The principal reason for adopting this speed, however, is that, when the centrifugal force is taken into consideration, a total load of from 200 to 225 lbs. per sq. in. section gives a maximum of efficiency when the belt runs at 4,000 to 4,500 ft. per minute.

In this connection, I wish to call attention to the remarkable formula, developed by Mr. Wilfred Lewis, for determining the maximum economical speed of belting corresponding to given total load.

The writer regards this as one of the few valuable bolting formulas deducted exclusively from theoretical considerations, and as its value appears to have been rather overlooked, he takes the liberty of quoting from Messrs. Lewis and Bancroft's experiments, made for Wm. Sellers & Co., as follows:

> V = velocity of belt in feet per second.
>
> S = working strength of leather in pounds per square inch.
>
> The velocity at which the maximum amount of power can be transmitted by any given belt is independent of its arc of contact and coefficient of friction, and depends only upon the working strength of the material and its specific gravity.
>
> From equation we obtain for the maximum power of leather belts the condition:
>
> $$V = \sqrt{28 S};$$
>
> and for any other material whose specific gravity is y, we find
>
> $$V = 5\sqrt{\frac{S}{y}}$$

If we insert in the above formula the total load of 200 lbs., which the writer believes to be most economical load, we have 4,500 ft. as the speed of maximum efficiency of the belt.

Distance Between Shaft Centers.—The best distance between shaft centers is 20 to 25 ft. With a greater distance the slack side is apt to flop about too much; with less the belts require tightening oftener than is profitable.

Pulley Faces.—The faces of pulleys should be, where practicable, made about one-fourth wider than the belts which run on them, to allow for possible uneven stretch or running of the belt and a certain amount of chasing.

Idler Pulleys.—When a belt must run night and day throughout the week without stopping, each important belt should be supplied with an idler pulley which can be tightened upon it while running in case of slip. Idler pulleys work most satisfactorily when located on the slack side of the belt, about one-fourth its length from the driving pulley. In this position it wears the belt far less than if placed close to the driven pulley and has less tendency to guide the belt off the pulley in case it is slightly misplaced or the belt stretches unevenly.

Thickness of Belts.—Belts are more durable and work more satisfactorily made narrow and thick, rather than wide and thin. It is advisable to use double belts on pulleys 12 ins. to 20 ins. diameter, triple belts on pulleys 20 ins. to 30 ins. diameter and quadruple belts on pulleys 30 ins. diameter, or larger. As belts increase in width they should also be made thicker.

The chief characteristic in which the oak tanned and fulled belts differed from the others was their stiffness. They were far less pliable than any of the others, and I am inclined to attribute a considerable part of their superiority to this property. Certainly, lateral stiffness is a most desirable quality in a belt which is to be used either as a shifting belt or on cone pulleys. A pliable belt used under these conditions is far more apt to curl up on the edges, and to climb and stretch against the side of the cone, and finally twist up like a corkscrew. A large proportion, also, of the so-called accidents to belting, in which they jump from one cone to another, or run into neighboring gears, are due to excessive pliability.

A manifest advantage of belts made of two or more thicknesses of leather lies in the fact that any local imperfection of the leather will produce but little effect in a double or triple belt, while in a single it is fatal.

Messrs. Bancroft and Lewis have, in their experiments, demonstrated the fact that "no marked difference could be detected in the power required to run a wide double belt or a narrow light one for the same tension at moderate speeds." And again, we see ropes up to 2 ins. in diameter transmitting power with great efficiency and with apparently but little loss of power owing to their thickness. Therefore, a thick belt will be practically no less efficient than a thin one on account of its stiffness.

Many experimenters have shown that the pulling power of belting for a given arc of contact is almost independent of the area of the belt in contact with the pulley, and that it depends chiefly upon the sectional area of the belt and its total tension, so that a triple belt will transmit about as much power as a single belt three times its width.

With wide belts, and belts running at high speed, it is especially desirable that the thickness should be increased. If thin belts are used at high speed they almost invariably run in waves on the slack side, particularly if the load which they are transmitting changes suddenly. These waves frequently continue in the belt while it is rounding the driven pulley, so that one can sometimes even see light in places between the belt and pulley rim when standing in the proper position. This wrinkling of the belt and the snapping that occurs as the waves straighten out, wear it very fast, and cause the splices to part, frequently in a few months. The remedy for this trouble I have invariably found to be an increase in the thickness of the bolt. When a sufficient thickness is used the belt settles down on the same pulleys and under the same conditions to a long, steady curve on the slack side and the wrinkling and snapping cease.

It would seem also as though a certain ratio of thickness to width of belt should be maintained, particularly in high-speed belts, otherwise the belt is apt to chase from side to side on the pulleys. This chasing would seem to be due chiefly to the oscillation of the belt around its longitudinal axis on the slack side, the belt being thereby tightened, first at one edge and then at the other, each side as it is tightened tending to run toward the center of the pulley. This oscillation, and the resultant chasing, are almost sure to cease when the thickness of the belt is increased in proper proportion to its width.

As an illustration of this principle the writer has in mind the case of a belt 78 ins. wide and nine-sixteenths inch thick, running about 5,500 ft. per minute, which could never be prevented from chasing from side to side on its pulleys for any length of time without the use of an idler pulley. This chasing was due to the oscillation about its longitudinal axis, which was caused by the small thickness of the belt in relation to its width.

A belt ⅞ in. thick and 72 ins. wide, used on the same pulleys, was almost entirely free from the chasing, and I am convinced that an increase to 1⅛ ins. in thickness would have rendered it sufficiently stiff to permanently remove the trouble. It should be noted that the thicker belt proved to be far more economical, durable and satisfactory in every way than the thin belt.

If the principle is correct, of using thick belts on account of their lateral stiffness and consequent durability, it becomes of the utmost importance to determine the minimum diameter of pulley which can be used with a given thickness of belt and still have the belt last well. The writer is quite sure that double leather belts ⅝ in. thick will last well and give excellent satisfaction on pulleys as small as 12 ins. in diameter, as he has had many belts in use for years under these conditions.

For some time past he has had a triple leather belt 12 ins. wide, 0,56 in. thick, running about 4,500 ft. per minute, with an idler pulley pressing lightly upon it, and transmitting about 100 HP. to a pulley 12 ins. diameter. This belt has, up to date, given excellent satisfaction, and has already lasted much longer than the two double leather belts which preceded it.

The writer is certain from his experience that the rule for variation of belt thickness, with pulley diameter above given, is a safe one and he would even go further and use double, triple and quadruple belts on pulleys 9, 15 and 24 ins. in diameter.

Splicing.—The ends of the belt should be fastened together by splicing and cementing, instead of lacing, wiring or using hooks or clamps of any kind. V-splice should be used on triple and quadruple belts and when idlers are used. Stepped splice, coated with rubber and vulcanized in place, is best for rubber belts.

I think it safe to say that the life of belting will be doubled by splicing and cementing the belt, instead of lacing, wiring or using hooks of any kind. When belts are subjected to the most severe usage the spliced portion should be riveted, iron burrs being preferable to copper. For double belting the rule works well of making the splice for all belts up to 10 ins. wide, 10 ins. long; from 10 ins. to 18 ins. wide the splice should be the same width as the belt, 18 ins. being the greatest length of splice required for double belting.

Cleaning and Greasing.—Belts should be cleaned and greased every five to six months, just enough grease being put on to keep the surface of the belt moist and prevent it cracking.

Tightening, Tension and Total Load.—When practicable, belts should be tightened by moving one pulley away from the other. Countershafts should be mounted on frames, and raised in tightening vertical and diagonal belts.

Belt clamps having spring balances between the two pairs of clamps should be used for weighing the tension of the belt accurately each time it is tightened.

When it is impracticable to accurately weigh the tension of a belt in tightening it, it is safe to shorten a double belt ½ in. for every 10 ft. of length, if it requires tightening, when working, according to the ordinary rules, under a total load of 111 lbs. per in. of width and giving an effective pull of 65 lbs. per in. of width. If it works under a total load of 54 lbs. and effective pull of 26 lbs., it is safe to shorten the belt 1 in. for every 10 ft. of length, when it requires tightening.

Belts should be tightened and repaired and cared for out of working hours by one man as far as practicable, careful inspection as to their condition being made at regular intervals.

Double leather belts will last well when repeatedly tightened under a strain (when at rest) of 71 lbs. per in. of width, or 240 lbs. per sq. in. section. They will not maintain this tension for any length of time, however.

If double leather belts are tightened while at rest to 71 lbs. per in. of width, and subjected to an additional working load of 65 lbs. per in. of width, their tension will fall in 2½ months so as to be while at rest, 33 lbs. per in. of width, or 106 lbs. per sq. in. section; their average tension during these 2½ months is 46 lbs. per in. of width, or 150 lbs. per sq. in. section. Their average total load during these 2½ months is 111 lbs. per in. of width, or 358 lbs. per sq. in.-section. These are the conditions under which belts work when tightened according to the ordinary rules.

When double belts are first tightened to 71 lbs. per in. of width, and then subjected to an additional working load of 26 lbs. per in. of width, their tension falls in 22 months to 21 lbs. per in. of width, or 68 lbs. per sq. in.-section. The average tension during this time is 28 lbs. per in. of width, or 90 lbs. per sq. in.-section; and the average total load is 54 lbs. per in. of width, or 174 lbs. per sq. in.-section. These conditions are rather less severe on belting than the rules which we recommend as most economical.

The most economical average total load for double belting is 65 to 73 lbs. per in. of width, i. e., 200 to 225 lbs. per sq. in.-section. This corresponds to an effective pulling power of 30 lbs. per in. of width, and with the rules for driving power given above.

Life of Belting.—Double leather belts, when treated with great care and run night and day at moderate speed, should last for seven years, when under average total load of 111 lbs. per in. of width, or 358 lbs. per sq. in.-section. They should last for 18 years when under average total load of 54 lbs. per in. of width, or 174 lbs. per sq. in.-section.

A total load of 111 lbs. per in. of width corresponds to a pulling power of 65 lbs. per in. of width. A total load of 54 lbs. per in. of width corresponds to a pulling power of 26 lbs. per in. of width.

The total life of belting, cost of maintenance and repairs and the interruptions to manufacture caused by belts, are dependent upon the total load to which the belts are subjected, more than upon any other condition. The other conditions chiefly affecting the durability of belting are: 1. Whether spliced, or fastened with lacing or belt hooks. 2. Whether they are properly greased and kept clean and free from machine oil. 3. The speed at which they run.

The speed at which belting runs has comparatively little effect on its life until it passes 2,500 to 3,000 ft. per minute.

Cost of Belting.—In a machine shop, the average cost in dollars per double belt per year of service, including original cost and cost of maintenance and repairs, proved to be $6.72 for such belts as were used under the ordinary rules (111 lbs. total load per in. of width, giving an effective pull of 65 lbs. per in. of width), and the cost was found to be less than $5.70 for belts under a total load of 54 lbs., giving an effective pull of 26 lbs. per in. of width.

The cost of all labor and materials used in the maintenance and repairs of double belts, added to the cost of renewals as they give out, through a term of years, will amount on an average per year to 37% of the original cost of the belts, if the belts are tightened according to the ordinary rules, and work under a total load of 111 lbs. per in. of width, giving an effective pull of 65 lbs. per in. of width. If, however, the belts are working according to a more economical rule, under a total load of 54 lbs. per in. of width, and an effective pull of 26 lbs. per in. of width, the annual cost of maintenance, repairs and renewals amounts to not more than 14% of the first cost, probably less.

The cost of maintenance and repairs of double leather belts amounts through a total life of 6.7 years (running night and day) to 1½ times the first cost of the belts, when belts are working, according to the ordinary rules, under a total load of 111 lbs. per in. of width, and are giving an effective pull of 65 lbs. per in. of width.

When, however, the belts are working according to a more economical rule, under a total load of 54 lbs. per in. of width, and give an effective pull of 26 lbs. per in. of width, the cost of maintenance and repairs, through a term of 8.8 years, amounts to only 30.4% of their first cost.

Stretch of Belting.—The total stretch of leather belting certainly exceeds 6% of the original length.

The stretch during the first six months of the life of belts is 36% of their entire stretch, in the case of double belts working, according to ordinary rules, under a total load of 111 lbs. per in. of width, and giving an effective pull of 65 lbs. per in. of width.

If, however, the belts are working according to a more economical rule, under a total load of 54 lbs., giving an effective pull of 26 lbs., the stretch during the first six months is 15% of entire stretch.

A double belt will stretch 0.47% of its length before requiring to be tightened, when subject, according to ordinary rules, to a total load of 111 lbs. per in. of width, and giving an effective pull of 65 lbs. per in. of width. A double belt with total load of 54 lbs., effective pull of 26 lbs., stretches 0.81% before requiring tightening.

Interruptions to Manufacture.—The most important consideration in making up tables and rules for the use and care of belting is how to secure the minimum of interruptions to manufacture from this source.

The average double belt, when running night and day in a machine shop, will cause at least 26 interruptions to manufacture during its life, or 5 interruptions per year, if the belts work, according to ordinary rules, under a total load of 111 lbs. per in. of width, and give an effective pull of 65 lbs. per in. of width. If, however, they work according to a more economical rule, under a total load of 54 lbs., giving an effective pull of 26 lbs., then the interruptions to manufacture will not average oftener for each belt than one in 16 months.

Best Type of Belt.—In a carefully conducted experiment between different types of leather belts, made in a machine shop, lasting nine years, between 40 and 50 belts being used, the oak-tanned and fulled belts showed themselves to be superior in all respects except the coefficient of friction to either the oak-tanned not fulled, the semi-rawhide, or rawhide with tanned face. They lasted longer, caused fewer interruptions to manufacture, did not stretch unevenly, stretched less, cost less per year of service, required tightening only half as often, and gave less trouble when first started than their competitors.

Shifting Belts.—Belts of any width can be successfully shifted backward and forward on tight and loose pulleys. Belts running between 5,000 and 6,000 ft. per minute, and driving 300 HP., are now being daily shifted on tight and loose pulleys, to throw lines of shafting in and out of use.

Shifting belts are much to be preferred to cut-off couplings, or friction clutch pulleys, for throwing heavy lines of shafting in and out of use.

The best form of belt shifter for wide belts is a pair of rollers twice the width of belt, either of which can be pressed onto the flat surface of the belt on its slack side close to the driven pulley, the axis of the roller making an angle of 75° with the center line of the belt.

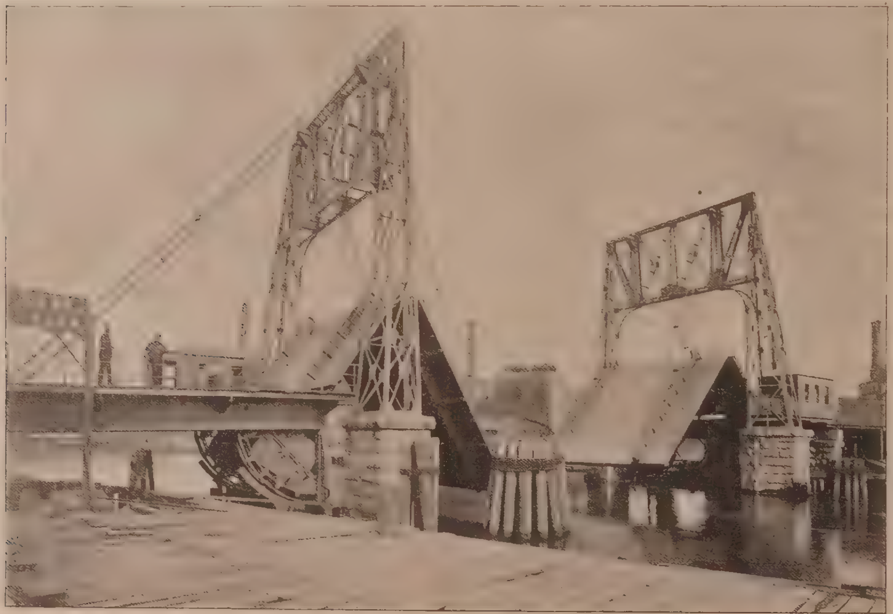
TRACTION ENGINES AT THE WORLD'S COLUMBIAN EXPOSITION.

Traction engines made an unexpectedly large showing at the Exposition, but as the majority of them were included in the machinery annex of the Agricultural Department, they were doubtless overlooked by many engineers, on account of the number of other exhibits which claimed first attention. Few persons, in the cities at least, realize the extent to which such engines are used for agricultural purposes in many parts of the United States. There were no less than 13 different makers who took part in the exhibition. While each had certain specialties in design, the majority of engines exhibited were of the familiar type with horizontal tubular boiler, and cylinders mounted on the boiler and driving the rear pair of wheels, the arrangement resembling that of a steam roller. The Frick Co., of Waynesboro, Pa., makes its machines in three sizes, with cylinders 7×9 ins., 7½×9 ins. and 8×10 ins. The Huber Mfg. Co., of Marion, O., employs a return tube boiler, with smokebox and stack over the firebox. There is a cylindrical fire flue, leading to a smokebox or combustion chamber, at the front end, with small return tubes to the stack. The cylinder is at the firebox end of the boiler, and the water tank is attached to the other end. Spring driving wheels are used, with car springs between the bearings of the hub. The reversing gear is of the Woolf type. The Aultman & Taylor Machinery Co., of Mansfield, O., uses a locomotive boiler, with cylinder mounted on the firebox end, and driving by bevel gear an inclined shaft, which transmits the motion to the bevel gear of the driving wheels. The engines are of 8 HP. to 18 HP., and are fitted with the Woolf valve gear, which has but one eccentric. The boilers are tested by hydraulic power to 200 lbs., and by steam to 120 lbs. per sq. in. They are made either as coal, wood, or straw burners. The Walker engine of the Union Iron Works Co., of Newark, O., is also of the ordinary type, but has the cylinder over the smokebox, and has the gearing carried by an independent frame so as to relieve the boiler of strain. A single eccentric valve gear, a flywheel governor and a balanced valve are used. The Minneapolis Threshing Machine Co., of Minneapolis, Minn., has an engine with return flue boiler, with cylinder at the firebox end, and fitted with the Woolf valve gear and reversing gear. The Geiser Mfg. Co., of Waynesboro, Pa., makes an engine with locomotive type boiler, having the cylinder mounted over the middle of the barrel and driving a shaft over the firebox. The boiler has a water-lined smokebox and a patented crownsheet protector to hold water on the crownsheet in descending grades. The engine has a piston valve, a single eccentric valve gear and a variable cut-off. It is fitted with flexible connections to insure steadiness on rough roads. Gaar-Scott & Co., Richmond, Ind., exhibited an engine of the usual type, with single cylinder at the firebox end of the boiler. The Westinghouse Co., Schenectady, N. Y., had an engine with vertical boiler. Engines of the ordinary type were also shown by A. W. Stevens & Son, of Auburn, N. Y.; Robinson & Co., of Richmond, Ind.; and Birdsall & Co., of Auburn, N. Y. A compound engine was exhibited by H. Abell, of Toronto, Ont., and a simple engine with return flue boiler and a crankshaft by the Sawyer & Massey Co., of Hamilton, Ont. The boiler of the latter has a 24-in. fire flue and 22 return tubes 2½ ins. diameter. The cylinder is at the firebox end, and the valve gear is of the link type.

We have not entered into the details of the construction of the various engines, but enough has been said to show that their manufacture is an important industry. In our issues of Oct. 27, Nov. 10 and Dec. 1, 1892; Jan. 5 and March 2, 1893, will be found some interesting articles on the construction and use of traction engines for road, agricultural and other purposes.

CANAL ST. FOLDING BRIDGE, CHICAGO, ILL.

In our issue of May 23, 1891, we illustrated and described a novel type of folding drawbridge invented by Mr. Wm. Harman and built by Shailer & Schniglau, of Chicago, Ill., for the Weed St. crossing of the Chicago River. The same firm has recently completed a second bridge of the same type, but embodying several improvements in its construction and operation, at the Canal St. crossing of the Chicago River, which we illustrate in the accompanying engraving. As will be seen from the engraving, each half of the bridge consists of a pair of towers with a connecting portal, from the top of which are suspended by tie-rods the two leaves which form the floor of the half span. These leaves are hinged together at their point of junction, and when the draw is to be opened this point rises, and the ends of the leaves move downward and fold close together. The engraving shows the leaves of each half about half closed and indicates very clearly the whole operation. It will be noticed that two of the tie-rods from each tower connect with the inner leaf at a point near the hinged joint and the two others with the end of the outer or center leaf. In folding the end of the center leaf describes an arc, of which the outer tie-rods are the radius, while the inner rods buckle up on the hinged joint shown near the bottom; these latter rods are, however, not essential parts of the design and have been left off entirely in a later design. The general operation of the draw will be understood from this description and the engraving.



CANAL ST. FOLDING BRIDGE, CHICAGO, ILL. Contractors, Shailer & Schniglau.

The Canal St. bridge gives a clear opening for the passage of vessels of 80 ft., and has a roadway 20 ft. wide in the clear and two sidewalks, each 6 ft. wide in the clear. The roadway was calculated for a live load of 100 lbs. per sq. ft., and for a road roller weighing 11½ tons. The sidewalks were proportioned for a live load of 80 lbs. per sq. ft. The site of the bridge is in the center of the coal and lumber district, where the traffic is very heavy and it has proved itself very rigid under heavy loads. Although there is no connection at the center, there is said to be no more vibration in either a vertical or a horizontal direction during the passage of heavy teams, than there is in an ordinary swing bridge or fixed span.

The bridge can easily be opened or closed in 15 seconds, and the time actually occupied in its daily operation is about 20 seconds. The chief advantage claimed for this bridge over the ordinary swing span is that it leaves the middle of the river clear and unobstructed for the passage of vessels, and allows the free use of the adjoining dock properties up to the boundaries of the street. Next in importance is the fact that when open for vessels, it is itself becomes a perfect obstruction and bridge guard against highway travel.

The bridge is operated by an engine geared directly to a transverse horizontal shaft on each side, this shaft operating sprocket wheels carrying link belts attached by crossheads to the shore ends of the inner girders, which, guided by a segmental frame, plainly shown in the photograph, open and close the bridge. The counterweight, which is required merely during a small part of the opening and closing process to overcome the slight rise in the combined centers of gravity of the girders and floor system during the opening, consists of a box filled with concrete extending across the entire width of the bridge and hung on the shore end of the pivoted girders. The box is constrained to move in the arc of a circle by arms attached and turning on the trunnions that support the pivoted girders. The counterweight varies in its effectiveness on the principle of a pendulum, and, after traveling through about ⅛ of a circumference, with gradually decreasing effective force, it comes to rest when the supporting arm is in a vertical position, while the ends of the girders move on for the rest of the stroke independently of the weight, and pick it up again in the return.

As stated before, this is the second bridge of this type to be constructed. A third is now being designed for the city of Milwaukee, Wis., and Messrs. Shailer & Schniglau, who control the rights to its construction, inform us that other cities are considering its adoption. We are indebted to these gentlemen for the matter from which our illustration and description have been prepared.

THE MACHINE TOOL EXHIBIT AT THE COLUMBIAN EXPOSITION.

II.

Special Machine Tools.

In addition to the very large display of general machine tools at the Columbian Exposition, reviewed in our issue of Nov. 23, a number of firms made exhibits of tools for special lines of work which were of much interest and value. These comprised machines for a great variety of purposes and they were naturally much more widely scattered among the different buildings than were the general tools, but the great bulk of the exhibits, especially of metalworking tools, were in Machinery Hall, and in many cases they attracted fully as much attention as the more showy neighboring displays of lathes and millers, etc. The screw and the bolt and nut machines, which were usually in operation, especially appeared to attract attention and were nearly always surrounded by a knot of sightseers, who watched with interest the rapid production of these small articles of daily use.

Pipe Cutting and Threading Machines.

Perhaps the most complete exhibit of any one line of special tools was made by the manufacturers of pipe fitters' hand tools and machines for threading and cutting gas and water pipes, etc. Several firms had quite complete exhibits of these machines for all sizes of work and operated both by hand and power.

The Jarecki Mfg. Co., of Erie, Pa., showed a full line of pipe cutting and threading machines driven by hand, belt, attached engine and electric motor. The electric motor driven machines presented an especially compact and neat appearance and were provided with rollers, upon which they could be easily moved from one place to another, which being done, all that is required is a simple connection with an electric power wire to make them ready for operation. Great care has been shown in arranging all the adjustments of the head, which is in fact the heart in the anatomy of a pipe threading machine, so as to be easily and quickly made. After the pipe is threaded all that is necessary is to open the dies and run the head back instead of much more slowly backing off, as is often the case. The head is also provided with an adjustable stop pin, which would seem to be very convenient when a large number of pipes of the same size are to be threaded. Ordinarily, every time a pipe is to be threaded the dies must be reset, but with the adjustable stop the dies are first set to the size to be threaded, then the stop set and secured, which will only allow the cam to move to the point required to thread this size. If the pipe is to be cut off the dies will open far enough to admit the pipe passing through them to the knife. About a dozen machines were shown for working from ¼ in. to 12 ins. diameter pipe.

The Armstrong Mfg. Co., of Bridgeport, Conn., exhibited a large number of hand and bench pipe fitters' tools and four power-driven machines for working pipe up to 6 ins. in diameter. A novel point in these tools was that the gears and bearings are inclosed in an oil chamber, which keeps them lubricated and free from chips and dirt. The adjustments of the head are conveniently operated. Among the smaller tools was shown a nipple holder which appeared to be an unusually simple and efficient tool. It consisted merely of a tube which is threaded internally at both ends with pipe taps, so that either end will receive the threaded end of a nipple. In the middle of the length of the tube is a slot passing through from side to side, and in this slot is placed a taper key which serves to hold a plug which is put in loose in the tube. When one end of the nipple has been threaded it is screwed into this tube until it comes in contact with the plug which is held up by the key. The blank end of the nipple is then threaded and the key driven out which loosens the plug and allows the nipple to be easily removed; and without damage to the threads. Each holder accommodates two sizes of nipples.

The Merrill Mfg. Co., of Toledo, O., showed a line of their pipe cutting and threading machines operated by power and hand. A feature of all of these is the company's standard adjustable quick-opening and closing die head, very simply operated by a lever and cam movement. Some of the heavier machines had the cones centrally over the machine, thus equalizing the weight and placing the belt in a convenient position. Within the cones were compound gears, giving six changes of speed. In these machines the vice is self-centering and feeds the pipe into the dies by a friction, universal lead screw connecting the vice frame to the die head by a cam closing the lead nut onto the screw. A reverse movement of the cam releases the lead nut. The pipe can also be fed into the dies by the hand wheel. The dies can be opened while threading, the threaded pipe removed, another pipe inserted, cut off, and threaded without stopping the machine.

Curtis & Curtis, of Bridgeport, Conn., had a very complete display of small tools and appliances for pipe fitters' use, and a number of hand and power-driven pipe threading machines. One of these, working pipe up to 8 ins. diameter, was shown in operation, and had been in use on the Fair grounds for about a year doing a large part of the piping for the buildings.

Bolt and Nut Machinery.

The Capitol Mfg. Co., of Chicago, Ill., had a small but unusually interesting exhibit of bolt threading and nut tapping machines, in which, perhaps, the machine which attracted the most attention was a Cook automatic nut tapping machine adjusted for working ¼-in. nuts. This machine was in operation turning out 40 finished nuts per minute or about 25,000 per day. To operate the machine the nut blanks are simply thrown into a hopper, from which they are conducted by an inclined pipe to the tap and there threaded, sized and cleaned ready for the bolt. In addition to this nut tapper, the company also showed a bolt threading machine fitted with their lead screw device for securing accuracy of thread on special work. This lead screw is attached to the side of the machine, as in a lathe, and operates through a split nut on an apron of the carriage. The split nut is operated by a lever which in turn is actuated by a stop arm and disengages the nut at any point desired. Changes of pitch are made by changing the gears exactly as in a lathe.

The Acme Machinery Co., of Cleveland, O., showed eight machines, among which the most noticeable were a 2-in. special thread cutting machine, a taper threading machine and a 1½-in. bolt heading and forging machine. The special thread cutting machine is provided with power-feed and lead screws, and is designed for threading jack screws, vise and chair screws, bridge rods, etc., where deep cuts are required. The taper threading machine was peculiar in that the taper is not produced by taper dies, as is usual, but by dies made straight like ordinary bolt dies, which open as the thread is cut. The third machine noted is designed to head bolts and for all forging work of a similar character. It is especially strongly built and is intended for heavy work.

The National Machinery Co., of Tiffin, O., made an exhibit of its standard bolt threading and nut tapping machines, which are so well known as to need no particular mention. These machines were all fitted with the company's standard heads, dies, head screw attachments, etc.

Screw and Nail Machines.

Two machines embodying, perhaps, the latest developments in the art of making wood screws and cut nails were exhibited respectively by the American Screw Co., of Providence, R. I., and Severance Nail Machine Co., of Duluth, Minn.

The exhibit of the American Screw Co. consisted of a set of its machines for making wood screws by the cold forging or swaging process. This set of machines consisted of two machines, one for heading, slotting and pointing the wire and the other for threading the blank prepared by the first machine. The only removal of metal by cutting is in pointing the screw. Perhaps the most novel part of the work is the threading done by the second machine. Two steel dies having grooves in their faces at angles to correspond to the screw threads move past each other in a straight line with sufficient room between them for the blank to be rolled along by the motion. This space gradually decreases so that the metal as the blank rolls is gradually squeezed or swaged to form the threads. One screw is threaded at each stroke of the dies. The screw blanks are placed in a hopper and fed automatically to the dies.

The cut nail machine shown by the Severance Nail Machine Co. was entirely automatic in its action and is an attempt to provide cut nail manufacturers with a machine equally as economical in operation as the automatic machines used by wire nail manufacturers. In the active competition between cut and wire nail manufacturers the former have been at a disadvantage, notwithstanding their cheaper raw material, owing to the large amount of hand work required to feed their machines. Briefly stated, the operation of the machine shown is as follows: The metal strip is fed through two rolls until it comes between one pair of four sets of knives which operate upon it alternately. The material can be cut either hot or cold, provisions being made for heating it on its way to the knives. The shape of the nail cut by this machine differs considerably from that of the ordinary cut nail, the head being of a much stronger form and the penetrating end pointed, both of which are extremely desirable features as we shall show in an early article on the holding power of nails. The production of these machines of course varies with the size of the nail cut, and it was said that one skilled operator with the assistance of three or four common laborers, could run from six to ten machines.

Miscellaneous Tools.

In addition to their exhibit of general machine tools (Eng. News, Nov. 23), Warner & Swasey, of Cleveland, O., showed an automatic valve boring and tapping machine for boring and tapping brass or iron valves. The valves to be operated upon are placed in chucks, of which there are three set in a revolving disk, which is properly indexed to bring the valves into position into line with the spindles, of which there are four, two in front for boring and facing, and two at the back for tapping. The same cutters both bore and face, the speed of the feed being automatically reduced when the facing begins. While the boring and facing is being done at the front the tapping is being done at the rear, the spindles being automatically reversed to run the taps out. Meanwhile the operator is placing a new blank in the uppermost chuck, thus making the work continuous. The capacity of the machine is from 1,800 to 2,200 1-in. valves per day.

J. H. Williams & Co., of Brooklyn, N. Y., showed a fine line of drop forgings, comprising wrenches, lathe dogs, cutter wheels for pipe cutting machines, shafting collars and a great variety of special shapes. This exhibit was especially interesting, as showing what a great variety of articles are now made by this process. Drop hammers and drawing presses were also exhibited by another Brooklyn firm—E. W. Bliss & Co. Many of these machines were shown in operation.

The Manhattan Elevated Railroad Company has been at work for some time putting in a third track on its Ninth Ave. line below 59th St. The city enjoined the company on the ground that it was building a third express track without authority. At the hearing of Dec. 12 the argument came to an abrupt end by the declaration of the railway company's attorney that it was building "a siding" and not an express track, and had full authority to do this from a commission appointed in 1867 and still in existence, a fact seemingly overlooked by the city attorney. It is the company's intention to replace 15-ton by 24-ton locomotives, and the change in its superstructure was made necessary. The express trains are to run on the old tracks, while the new third track will be used as a turnout for local trains.

Remarkably good work in hard rock tunnel driving is now being done on the Palisades tunnel of the New York, Susquehanna & Western R. R. near New York (Eng. News, March 30, 1893.) This work has been under way about a year, and it is expected that the tunnel will be completed early in 1894. During the past month the contractors, Messrs. Brodhead & Hickey, drove on the east end of the tunnel, which is in charge of Mr. P. F. McLaughlin, 161 ft. of heading and 186 ft. of bench, all double track tunnel, dimensions 27 ft. × 21 ft. The record in the heading is notable, owing to the fact that the work was done by night shift only, that is, only one shift in 24 hours. This plan was first introduced by Mr. McLaughlin, and has proved so successful that it has since been adopted elsewhere. One of the main advantages of the single shift is that after the drilling and firing, which takes place early in the morning, common muckers are put to work in the heading to get rid of the broken stone, and the men in charge of these muckers sees that the columns are put up and the drills in place for the runners to begin work again on the following night. The rock encountered is the well known Jersey trap. This work has been done with four Ingersoll-Sergeant drills in the heading and six on the bench.

The traffic on the Erie Canal this year has been the greatest for years. From May 1 to Dec. 1 9,021 boats passed Lockport, N. Y., going east, and 8,421 boats went west. Added to the above were 220 cribs of timber. This record is about 3,000 more both ways than in 1892.

Eight miles per hour for trolley cars is the maximum speed recommended by the Brooklyn Grand Jury, in view of the frequency of fatal accidents from trolley cars in that city. The jury further recommends trained motormen, electric bells for use at crossings and the stationing of watchmen at the intersection of different cars routes with authority to govern speed at these intersections.

The 125-lb. hammer, erected in 1889-91 by the Bethlehem Iron Co., is the largest in the world. The only hammers that can compare with it are and the 109-ton hammer of the Terni steel works, in and Marrel Bros., of Rive de Gier, both in France, and the 100-ton hammer of the Terni steel works, in Italy. The heaviest English hammer is one of 35-tons, at Woolwich. The anvil block is made up of 22 accurately fitted iron blocks, forming a pyramidal mass and weighing 1,800 tons, whereas the Marrel block weighs only 760 tons. The hammer is 90 ft. high above the floor; the housings, in two parts, on each side, weigh 238 tons and are surmounted by an entablature weighing 61 tons; the base plates weigh 56 tons each. The steam cylinder above the entablature, which is only used to lift the hammer, is 24 ft. high and 76 ins. in diameter. The 16-in. steel piston-rod is 40 ft. long. This hammer is principally used as a finishing tool, as the same building contains a hydraulic press of 14,000 tons capacity, with two 50-in. rams operated by water under 700 lbs. pressure per sq. in.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BEECH CREEK.—Press reports state that surveys and purchases of coal lands indicate the building of a link between the Beech Creek and Pittsburg, McKeesport & Youghiogheny railways, in Pennsylvania. This probably means another through line from Cleveland and Pittsburg to the East, in competition with the Pennsylvania and Baltimore & Ohio, principally the former, as the entire route would traverse Pennsylvania territory. It will be a Vanderbilt line.

EBENSBURG & BLACK LICK.—This company was incorporated about a year ago to build a railway from near Ebensburg, Pa., on the Cambria & Clearfield, west through Indiana county to Black Lick, a distance of 35 miles, to develop coal lands. About 10 miles of grading was done last summer, but no track was laid. It is stated that the construction will soon be resumed and the road pushed to completion as rapidly as possible. The road is said to be a Pennsylvania line. Pres., Henry D. Welsh, Philadelphia.

LEHIGH VALLEY.—The Rochester, N. Y., chamber of commerce has interested itself in a proposed extension of this road from Honeoye Falls, N. Y., to Honeoye Lake, a distance of about 10 miles. The surveys for this extension were made some time ago.

NEW YORK, NEW HAVEN & HARTFORD.—A daily paper presents the following information: All the sections of this railway which have been four-tracked have been stone ballasted. Between New York and New Haven the 12 miles between the Grand Central Station and Woodlawn belong to the New York Central, and its four tracks are finished. From Woodlawn to New Rochelle Junction, about 4½ miles, the four-tracking is in progress and will be done in about a year. From New Rochelle Junction to Port Chester, about nine miles, the four tracks are complete and in use. From Port Chester to South Norwalk, about 16 miles, the work is in progress. There is here some exceedingly heavy work, which, with obstacles in acquiring real estate, may delay the four tracks for two years. From South Norwalk to the West Bridgeport city line, about 13 miles, the four tracks are finished and in use. From Bridgeport to New Haven the work is in progress, and will probably be finished in about a year. Between these two cities is the large Woodmount cut-off, which will save a distance of 1,000 ft., besides a heavy grade and curve. The four-tracking is complicated, and delayed by the large cost and trouble of acquiring right of way through Stamford, South Norwalk and Bridgeport, especially the latter city, where the expense will be very large indeed. Little has been done thus far in those branches of the work. The new loop just east of New Haven will probably not be done until next June. This new location involves a long and heavy fill, now almost done, across the Quinnipiack Meadows and a deep cut and tunnel through the East Haven hill, the tunnel to be some 70 ft. long. The cost of grading alone will be $600,000 for a distance of about three miles, and to that cost must be added bridges and rails. The road by the new loop is lengthened about three-quarters of a mile, but this is gained by straightening other parts of the Shore Line between New Haven and New London. Fourteen grade crossings in the city of New Haven, some of them very dangerous, will be eliminated by the new loop. When it is completed the old roadbed through Fair Haven is likely to be abandoned for railway purposes.

UNITED COUNTIES.—This railway has been extended from St. Hyacinthe, Que., to Iberville, 30 miles, and the line is to be continued north to Sorel, and south to Henryville, Clarenceville and Lacolle, according to reports.

WASHINGTON, WEST SHORE, BALTIMORE & DRUM POINT.—Van Aken & Hays, Washington, who are now building this road, expect to begin the tracklaying at Millersville, Md., this week, and to complete the line south to Drum Point as soon as possible. A large force of men is at work on the road and the ties have been distributed for several miles along the line.

Projects and Surveys.

ELKTON & SOUTHERN.—It is proposed to incorporate a company under this name to build a railway from the Baltimore & Ohio south through Elkton, Md., to Lambson's, on the Baltimore & Delaware Bay. S. C. Rowland was chairman and Capt. G. R. Ash secretary of a meeting held at Elkton, Md., Dec. 5, to promote the project.

GREENVILLE & NORTH LAWRENCE.—Incorporated at Steubenville, O., to build a railway from near Navarre, Stark county, to a connection with the Pittsburg, Fort Wayne & Chicago at North Lawrence; capital stock, $10,000; J. M. Cook, J. C. Bigger, F. H. Kerr, G. P. McCracken, T. A. L. Thompson.

MONONGAHELA RIVER & BROUGHTON.—Incorporated in Pennsylvania, to build a railway from Hayes' Station to Option, all in Allegheny county; J. A. Schully, Chas. Donnelly, Frank Armstrong, Pittsburg, Pa.

WASHINGTON & CHESAPEAKE BEACH.—It is reported that negotiations are being made for the right of way for this proposed road. The projected line is from Washington southeast about 27 miles to a place on Chesapeake Bay where it is proposed to establish a seaside resort. The contract for the construction was awarded to Godefferoy & How, New York, about a year ago. Ch. Engr., L. H. Hyer, Washington.

Southern—Existing Roads.

GLENDON & GULF.—Work on this railway has been resumed, according to reports. Ch. Engr., Frank D. Jones, Fair Haven, N. C.

HOLSTON VALLEY.—A press dispatch from Bristol, Va., to the Baltimore "Sun" states as follows: Work on the construction of the Holston Valley R. R. has not ceased for a day since it was begun last spring, except on account of bad weather. The grading is finished and half of it is ready for track to be laid. The bridgework is about finished except across the Holston River. The piers of the river bridge have been finished and the rest of the work will follow soon. It will require about three months to complete the road to the timber lands. It will probably require an equal length of time to bring the plant from Bluff City and establish it here. The plant will be brought to Bristol just as soon as the side track now being built from the water tank to the plant site is completed. The side track will be ready for trains in about 30 days. The projected length of the road is about 40 miles. Gen. Man., A. T. Willey, Bristol, Tenn.

MIDDLE GEORGIA & ATLANTIC.—Tracklaying on this road, which was suspended in June last, was resumed Nov. 30. The line is now in operation from Eatonton, Ga., to Starrsville, Ga., a distance of 37 miles. This company has also leased and is operating the road from Eatonton to Milledgeville, 22 miles. It is proposed to complete the line from Starrsville to Covington by Jan. 1, a distance of six miles. The grading for this is all done and the work now remaining is the tracklaying and building of 1,200 ft. of trestle. Ch. Engr., Arthur Pew, Macon, Ga.

TAMPA & THONOLOSASSA.—Press reports state that the grading of this proposed railway in Florida, 14 miles long, has been commenced by Morgan, Reynolls & Walker. The road will be built and equipped by the Plant Investment Co. Pres., S. A. Jones, Tampa, Fla.

WEST VIRGINIA CENTRAL & PITTSBURG.—It is stated that arrangements are being made to extend this railway to Charleston, W. Va. At present the line extends from Cumberland, Md., to Elkins, W. Va., 114 miles. Pres., Henry G. Davis, Piedmont, W. Va.

Projects and Surveys.

ROANOKE RY. CONSTRUCTION CO.—Efforts are being made to commence the construction of this proposed road, noted Nov. 23, early in the spring. A guarantee has been given, according to reports, that the road shall not pass under control of the Norfolk & Western.

Northwest—Existing Roads.

AHNAPEE & WESTERN.—The Sturgeon Bay, Wis., "Democrat" states that the construction of this railway was resumed last week about three miles from that city and that the work will be continued as long as the weather will permit. The line is projected to Ahnapee, Wis., 20 miles, and it is possible that the rails may be laid as far as Forestville this year. Pres., E. Decker, Ahnapee, Wis.

CHICAGO, PEORIA & ST. LOUIS.—Press reports state that 4,000 tons of steel rails have been purchased for the Havana and Springfield branch of this line.

DULUTH & WINNIPEG.—The Duluth "Evening Herald" states as follows: It is understood that at the meeting here on Dec. 14 plans for the extension of the Duluth & Winnipeg westward next spring will be definitely decided upon. The plans include an extension direct to the Red River Valley in the neighborhood of Crookston, and a branch from a point west of Lake Winnibagoshish running northwesterly to Winnipeg through Cass and Kittson counties to Emerson, Man., where connection will be made with the Canadian Pacific line now in operation from the international boundary to Winnipeg. This will give the Canadian Pacific a direct road from its main line at Winnipeg by way of Duluth to Sault Ste. Marie, then connecting with the Eastern division. The Duluth & Winnipeg plans also contemplate a line from the junction of its Crookston and Winnipeg lines direct south to St. Paul, but it is not likely that any work will be done on that extension next year. It would give the Canadian Pacific system a very short line between Winnipeg and St. Paul.

OMAHA BELT LINE.—This company is double-tracking its line, eight miles long, at a cost of $150,000. The work will include two new steel bridges.

WISCONSIN & CHIPPEWA.—About 25 men are at work clearing the right of way for an extension of this railway. Gen. Man., Wm. H. Bradley, Tomahawk, Wis.

Projects and Surveys.

LAKE SUPERIOR, SOUTHWESTERN & GULF.—Incorporated in Iowa to bring under one management a continuous railway direct from Duluth, Minn., to deep water on the Gulf of Mexico. The project includes 200 miles of new construction south from Aurora, Mo.; capital stock, $5,000,000; Pres., E. R. Bristol, St. Paul; Gen. Man., L. M. Martin, Des Moines, Ia. (Gen. Man., Des Moines Northern & Western Ry.); Secy., J. M. Miller, Springfield, Mo.

Southwest—Existing Roads.

GULF, COLORADO & SANTA FE.—An official of this road is reported to have stated that an extension of the line will soon be made to San Antonio, Tex., and the road completed within 10 months.

ST. LOUIS, CAPE GIRARDEAU & FORT SMITH.—Press reports state that Louis Houck, Cape Girardeau, Mo., is organizing a company to build a railway from Perryville, Mo., to Chester, Ill., by way of Fithian, Ill. Mr. Houck is president of the St. L., C.G. & Ft. S. and the route for the projected road is being surveyed by Maj. Brooks of this company.

SUGARLAND.—This road, which has been built by Cunningham & Miller as an outlet from the sugar plantaton and refinery operated by the firm to the International & Great Northern, has been completed and is now open for traffic. It is 13 miles long, extending from Sugarland, Tex., on the Southern Pacific line, to Arcola Junction, where connection is made with both the International & Great Northern and the Gulf, Colorado & Santa Fe.

Projects and Surveys.

BROWNSVILLE & CORPUS CHRISTI.—The proposition to build a railway between Brownsville, Tex., and Corpus Christi was described in our issue of Nov. 16. Press reports state that the construction of the road seems now assured. Cameron county has donated 41,600 acres of land and $28,000 in cash and 96 lots for terminal grounds at Brownsville.

HAMMOND & BLUE ISLAND.—Incorporated in Illinois to build a railway from a point on the Illinois-Indiana state line opposite Hammond, Ind., to Blue Island, Cook county, Ill.; capital stock, $100,000; directors, Silas H. Strawn, Ralph Martin Shaw, James T. Maher, Edward S. Whitney and James Miles; principal office, Chicago.

LITTLE ROCK, HOT SPRINGS & TEXAS.—This company has been organized at Hot Springs, Ark., to accept a proposition of Uriah Lott, ex-Pres. San Antonio & Aransas Pass Ry., who proposes to build a railway to connect Little Rock and Hot Springs, Ark., and Paris, Tex.; the line between Little Rock and Hot Springs to be completed by Jan. 1, 1895, provided the citizens of these two cities guarantee the right of way and subscribe for $100,000 of stock, the money not to be paid until the road is completed. The directors inclule Uriah Lott, J. P. Nelson, C. N. Rix, W. J. Little, D. C. Rugg and Ed. Hogaboom; capital stock, $100,000.

MISSOURI RIVER & CHICAGO.—Incorporated in Missouri to construct a railway from a point on the Missouri, Kansas & Eastern in Callaway county, near St. Aubert, and thence in a northwesterly direction to Fulton and Columbia, and thence in a northern and easterly direction to the Wabash, near Centralia, and thence through the counties of Audrain, Monroe, Ralls and Marion to Hannibal, a distance of about 120 miles; capital stock, $1,200,000; Charles H. Hammett, Lucius J. Smith, H. E. Serat, J. H. Harkless, A. D. Leech, R. C. Stripp, Amzi D. Austin, all residents of Kansas City. The survey for the route between St. Auberts and Fulton will be commenced at once, according to a reported statement of J. H. Harkless, attorney for the company.

ST. LOUIS BELT LINE.—Surveyors have been at work on a route for a new belt railway at St. Louis, Mo., according to reports, to commence north of the city limits and circle around the city to the west, coming in at Carondelet on the south and connecting with the new bridge to be built there. It is stated that this new belt road is a part of the plan of the Chicago, Burlington & Quincy to girdle the city on all sides and thus connect with every railway that enters it.

Rocky Mt. and Pacific—Existing Roads.

ATLANTIC & PACIFIC.—California papers state that construction will soon be commenced on a branch of this road to connect San Jacinto, Cal., and Lakeview, a new settlement in San Bernardino county.

BURRARD INLET & FRASER VALLEY.—C. D. Rand, Pres., Vancouver, B. C., is reported as stating that work will soon be commenced on the 2,300-ft. bridge to carry this railway across the Fraser River, at New Westminster, B. C. The right of way for the railway has been cleared within half a mile of New Westminster.

NEVADA SOUTHERN.—The Los Angeles, Cal., "Express" of Dec. 1 states as follows: The loan of $80,000 for the Nevada Southern R. R. construction is praccally all secured, and I. E. Blake, Pres., Denver, said to-day that the contract would be let next week for grading and tracklaying from the present terminus at Manvel to the lead fields at the state line, a distance of about 25 miles. This will give an important outlet for the lead ores, which have to be hauled in wagons over bad roads.

Projects and Surveys.

ALUM ROCK.—Reports state that this company has been incorporated to build a railway from San Jose to City Reservation, Alum Rock Canyon; capital stock, $300,000; R. H. Tumcey, J. T. Grant, Jacob Miller, San Jose, Cal.; J. J. Scrivner, San Francisco; H. M. Cameron, Oakland.

LAKE CHELAN.—Francis H. Cook, Spokane, Wash., has made a proposition to the citizens of Chelan Falls, Wash., to construct a railway from the Columbia River to Lake Chelan. If the proposition is accepted reports state that the construction of the road will be commenced in March, and that a large lumber plant will be located at the foot of the lake.

NATIONAL CITY & OTAY.—A report from San Diego, Cal., states that this road will probably be extended to Yuma, Ariz., the construction to be commenced in the spring.——A later report states that ties and rails have been ordered for an extension from La Presa into the Upper Sweetwater, through the Jamacha country into the eastern enl of Cajou Valley, a distance of about 10 miles. Ch. Engr., H. N. Savage, National City, Cal.

SAN FRANCISCO & ATLANTIC.—Press reports announce that the right of way has all been secured for this projected road between Oakland, Cal., and Los Angeles, by way of Stockton, 300 miles, that all the bonds have been taken by English capitalists, and that the road is to be completed before Jan. 1, 1896. Frederick Homer, San Francisco, is the projector of the road.

Foreign.

MEXICO.—A press report from the city of Mexico states as follows: In addition to the railway lines already in process of construction and projected in Mexico application has been made to the government for concessions for several additional roads, one of the most important of which is the application of Rafael M. de Arozarena, for a line from Pachuca to the city of San Miguel, by way of Real del Monte. Rafael Dorantes also wants Congress to approve a concession for a railway from Paso de Cosahuayaha to Pichuchalo, in the state of Chiapas.

MEXICO, CUERUAVACA & PACIFIC.—We are informed that construction work is progressing rapidly on this railway, projected between the city of Mexico and the Pacific coast, about 300 miles. The work was commenced at the city of Mexico nearly two years ago and the time of completing the entire road has been extended to Aug. 17, 1903, as stated some time ago. At kilometer 41 is a fill which will require four or five months of work on account of the nature of the material and location; borrowing is necessary to the extent of some 110,000 cu. m. of solid rock, the fill being 59 m. deep on the center line. This is said to be the heaviest railway grading ever constructed in the Republic and reflects the greatest credit on J. H. Hampson, president of the road, in keeping down the maximum grade of 2½%. The traffic on the operated line is very encouraging. The freight traffic at present consists principally of cotton and other supplies for the mills and haciendas located along the road. This will be greatly increased when the rails are laid from the present end of track at kilometer 33 to kilometer 41, at which point is located an extensive stone quarry of red grey sandstone, with perfect cleavage, which it is expected will be of great value for building and paving purposes to the city of Mexico.

HONDURAS.—A New Orleans, La., paper reports that Simon Barrio, of the firm of Jose Ruiz & Co., of New Orleans, recently returned from a trip to Honduras, where his firm has secured a concession for the construction of a railway from the highlands of Buenos Ayres to the coast between the points known as Juan Leandro and Juan Lopez, a distance of between 20 and 30 miles. Work will begin on the road within six months and is to be completed in two years. The road will open up a new section of banana farms and prove a great benefit to the port of New Orleans.

EGYPT.—A railway between Ismalia and Port Said was opened last week by the Khedive of Egypt. Reports state that much ceremony was observed at the opening of this new railway, which now joins the headquarters of the Suez Canal (Ismalia) with the Mediterranean entrance of the canal.

STREET RAILWAYS.

CALAIS, ME.—It is reported that the electric street railway company has arrived at terms with the St. Stephen municipal authorities and it now seems assured that the belt line will be constructed next year.

ABINGTON, MASS.—The directors of the Abington & Rockland Electric R. R. Co. have voted to petition the selectmen of this town to extend the franchises on Centre Ave. and Central St., which expire Dec. 31, to Jan. 1, 1895; also to petition for a franchise on Park Ave., that a loop line may be constructed next spring.

HAVERHILL, MASS.—The incorporators of the Haverhill, Georgetown & Danvers St. Ry. Co. will petition the legislature for permission to extend its tracks through Beverly, Wenham and Ipswich, according to reports. The petition will also ask for an extension of the time granted in the first charter to four years for the final completion of all the road and 30 months for a portion.

NATICK, MASS.—The Natick & Cochituate Electric R. R. Co. has been granted a franchise to extend its tracks through Wellesley, Wellesley Hills to Newton Lower Falls. The company will lay the tracks in the spring and the road must be completed and the cars running by July.

RANDOLPH, MASS.—F. A. Hobart is reported as stating that the work of building the electric railway will be resumed early in the spring and the road completed by early summer. A number of the cars have arrived and are stored for the winter at South Braintree.

BROOKLYN, N. Y.—The Thirty-ninth St. Ferry & Suburban R. R. Co. has been incorporated to build a street railway from the intersection of Thirty-eighth St. with the Bay of New York, in Brooklyn, to the intersection of Twenty-third Ave. with Gravesend Bay, in the town of New Utrecht, and to the intersection of the main road through Canarsie Village with Jamaica Bay or Flatlands Bay, in the town of Flatlands, a distance of 13 miles; capital stock, $500,000; directors, John Middleton, R. T. Betts, Sidney Edwards, Brooklyn; Theodore Jenkins, Gravesend; J. A.

Blanchard, Fort Hamilton; T. J. Meehan, W. S. Mercer, J. M. O'Brien, T. Foley, New York.

NEW BRUNSWICK, N. J.—The question of changing the motive power of the street railway lines in this city from horses to electricity is again being considered by the council.

BRIGHTWOOD, D. C.—A bill has been introduced in the house of representatives authorizing the Brightwood Ry. Co. to extend its tracks and to build a branch line using the overhead trolley system of motive power.

ATLANTA, GA.—A meeting was held at Atlanta Heights last week to raise a bonus of $35,000 to secure an electric railway between this city and Silver Lake, a distance of 14 miles. New York parties are said to have agreed to build the road if this sum is donated by the landowners, and $30,000 has already been secured.

JACKSONVILLE, FLA.—Col. H. S. Haines, Pres., Jacksonville St. Ry. Co., is reported as stating that the motive power of the street railway will soon be changed from mules to electricity.

NEW ORLEANS, LA.—J. W. Henning, Pres., New Orleans Traction Co., is reported as stating that electric cars will be used on every street for which a franchise can be secured. The work will be commenced at once.

ATTICA, IND.—It is reported that a company has been organized to build an electric railway to Indiana Mineral Springs.

BELLEVILLE, ILL.—The Belleville Electric Ry. Co. has been incorporated to build an electric railway in this city and to East St. Louis; capital stock, $300,000; directors, J. H. Atterbury, J. W. Griswold, R. Ross, Litchfield; J. J. McLean, Hillsboro; Paul W. Abt, East St. Louis.

CHICAGO, ILL.—The Leffler Electro-Magnetic Ry. Co. has been incorporated by P. W. Leffler, W. J. Pratt and Jas. Brady; capital stock, $1,000,000.

BEATRICE, NEB.—Efforts are being made to secure an electric railway to Adams, in the northeastern part of this county.

POMONA, CAL.—Bids are asked until Dec. 26 for a 50-year franchise for an electric railway in certain streets. J. R. Garthside, Cy. Clk.

REDLANDS, CAL.—The Redlands Electric Light & Power Co. is reported as considering the construction of an electric railway to Yucaipe.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The Chicago Elevated Rapid Transit R. R. Co. has been incorporated to construct an elevated railway from a point near Fifth Ave. and Kinzie St. to Evanston; capital stock, $1,000,000; Russell Whitman, G. A. Powell, W. O. Lindley.

HIGHWAYS.

NEW JERSEY.—The city council of Cape May has appointed a committee to arrange for the construction of a driveway along the beach. At the eastern end of the city it is proposed by private parties headed by John C. Bullitt and Thomas Robb, Philadelphia, to build an embankment and driveway from Madison Ave. to Sewell's Point, along the edge of Cape Island Sound, and to lay out streets in the East Cape May beach, and on the Cape May Athletic Club grounds, as well as to construct several cottages. It will cost the city several thousand dollars to complete the proposed improvement and employ its now idle workmen all winter.

MARYLAND.—A dispatch from Laurel, Md., to the Baltimore "Sun" states that in a short time operations will be commenced on the boulevard between Baltimore and Washington. It has been stated by one of the stockholders of this company that the contracts have been given out for the construction of this boulevard. The engineering corps has surveyed a number of routes between these cities and will soon be through. It is also said that the greater part of this road will be west of the Baltimore & Ohio railway, as this will save considerable time and expense, and a more direct line can be run which will take in a number of the thickly populated towns in that section.

IDAHO.—The state wagon road commissioners will meet at Boise City on Dec. 26 to open bids for the construction of the Salmon River and Elk City roads. Additional bonds for $38,000 have been sold.

BRIDGES AND TUNNELS.

NEW BRUNSWICK, N. J.—The commissioners of Middlesex county have appointed a committee of five to investigate the feasibility of a highway bridge across the Raritan River, connecting Perth Amboy and South Amboy. The bridge would be over a mile in length.

BALTIMORE, MD.—The contract for the new Maryland Ave. bridge over Jones' Falls has been awarded to the Pennsylvania Steel Co. at $13.489, the work to be completed within four months. The bridge will be of the steel triangular truss pattern, 122 ft. long, and was designed by Frederick H. Smith, Consult. Engr., Baltimore. The total bids were published last week. Contracts for two additional bridges will probably be awarded in the spring.

CINCINNATI, O.—The city engineer is preparing plans and specifications for a viaduct over Bold Face Creek. It will be 550 ft. long and 60 ft. above the present roadbed. The improvement will cost $60,000, and work will be begun in the spring.

MENOMINEE, MICH.—The contract for building a steel bridge over the Cedar River near the village of Cedar River has been awarded to the Detroit Bridge & Iron Works. The bridge is to be 210 ft. long, with an 18-ft. roadway, and is to be completed on or before next June.

MILWAUKEE, WIS.—The bids for the superstructure of the new Sixteenth St. viaduct were published last week. G. H. Benzenberg, Cy. Engr., informs us that the viaduct will connect the north with the south side of the Menomonee Valley. The superstructure will be of steel, 4,000 ft. long with a 40-ft. roadway and two 10-ft. sidewalks. The contract for the substructure, consisting of pile foundations and stone masonry, was awarded some time ago at $55.000. Bids will be asked within a few days for a folding bridge which is to span the North Menomonee River in connection with the viaduct.

ST. CLOUD, MINN.—Frank A. Smith, Cy. Engr., informs us that the contract for the new steel bridge has been awarded to the Penn Bridge Co., at $26,150 for the superstructure. The contract for the substructure was awarded to Foley Bros. & Guthrie at $14,600. The bridge consists of three 180-ft. spans, and two 6-ft. sidewalks. The bids for the superstructure were as follows:

Shiffler Bridge Co....	$34,173	Gillette-Herzog Co...	$28 000
Kenwood Bridge Co .	33.400	Wisconsin Bridge Co.	27.997
Wr'ght Ir. Bridge Co	29,500	Chicago Br. & Ir. Wks.	27.994
Mt Vernon Bridge Co.	29,100	Foley Bros.& Guthrie.	27,988
S. M. Hewitt & Co....	29,000	St. Jos. Br. & I. Wks.	26,826
Toledo Bridge Co.....	28.950	Wilw Br. & Ir. Wks.	26.390
N. J. Steel & Iron Co.	28,989	Penn Bridge Co.......	26,150

KANSAS CITY, KAN.—The question of a viaduct from bluff to bluff across the Kaw Valley to connect this city and Kansas City, Mo., is again being agitated, and, it is reported, with fair prospects of success.

NEWARK, NEB.—Over 30 ft. of the Burlington & Missouri River railway bridge just west of this place was burned last week.

YANKTON, S. DAK.—Press reports state that engineers supposed to be in the employ of the Great Northern are making soundings of the Missouri River at this place, and that it is confidently asserted that a railway bridge will be built somewhere in this vicinity in the spring.

WATER-WORKS.

NEWPORT, N. H.—There is talk of securing a supply from Gilman Pond, in East Unity.

NEWPORT, VT.—The village is planning to secure a new supply, according to reports, the present supply being pumped direct from the lake.

CAMBRIDGE, MASS.—The board has been authorized to contract for a supply of pipe, hydrants, etc., for next year.——L. M. Hastings, Cy. Engr., has reported the following estimates for the work referred to last week: 40,000,000-gallon distributing reservoir at Payson Park, $175,000; gate house and fittings, $25.000; 20.000.000-gallon vertical triple expansion, high-duty pumping engine, $130,000; two Belpaire locomotive type boilers, $25.000; foundations, $15.000; 1.800 ft. 40-in. main, $180,000; gates and fittings, $25,000.

HOLYOKE, MASS.—The commissioners have been granted the right to take the necessary steps for procuring the Granville supply for the city.

MARLBORO, MASS.—It is reported that the council has voted to issue bonds for $30,000 for extensions and improvements.

MEDWAY, MASS.—If the company incorporated in 1892 to put in works does not do so soon reports state that steps will be taken for a municipal plant.

MILLBURY, MASS.—The Millbury Water Co. is reported as taking steps to construct works. C. D. Morse, Pres.

NEW BEDFORD, MASS.—A contract for pipe has been awarded to R. D. Wood & Co., at $6,600. The total bids were published last week under Medford, by mistake.

QUINCY, MASS.—The citizens have accepted the water act of 1891, authorizing a supply from Blue Hill River, by a vote 1,792 to 449.——The council has appropriated $60,000 for extensions.

STONEHAM, MASS.—A town meeting has been called to vote on the question of purchasing the local works. This town and Wakefiell are suppliel by the Wakefield Water Co., and the town of Wakefield has alrealy taken action in favor of purchasing the plant.

BUFFALO, N. Y.—Bids are asked until Dec. 15 for $200,000 of temporary loan water bonds. Jos. E. Gavin, Cy. Compt.

MOUNT VERNON, N. Y.—The council is considering the question of works to be owned by the city, the present service not being satisfactory.

NEW YORK, N. Y.—The contract for two 10,000.000-gallon and two 4,000,000-gallon vertical triple expansion pumping engines, with boilers and appurtenances complete, for the high-service works at the new aqueduct, has been awarded to the Geo F. Blake Mfg. Co., at $110.000. The bids were published in our issue of Nov. 23.

YONKERS, N. Y.—The fire commissioners are preparing for important extensions of the mains, according to reports.

ASBURY PARK, N. J.—The Glendola Water Co. has been organized to put in works; capital stock, $159.-000; J. A. Githens, Wm. Larrabee, Asbury Park; J. C. Togg, New York; D. H. Hurley, Glendola; Geo. C. Beekman, Freehold, and others.

LORRAINE, N. Y.—The Lorraine Water Co. will receive bids within a few days for furnishing and laying pipe, hydrants, etc. The supply will be taken from the mains of the Union Water Co. Engr., W. J. Lansley, 334 Central Bldg., New York.

ALLEGHENY, PA—Julian Kennedy has reported in favor of a supply from Nine-Mile Island with a filtering plant, the estimated cost being as follows: Rights of way, $50,000; dams, dredging, etc., $65.000; pumping station, $710,000; main, $850,000; filtering plant, $300 000. The committee has accepted the report and voted to recommend that bids be asked for the work as soon as possible; also that an election be held to vote on the issue of additional bonds, only $1.250,000 having been appropriated for this work.——S. W. Hill has submitted a paper to the committee stating that 23,000.000 gallons of water are used daily for mechanical purposes in the city, and advising that another system of pipes be laid to supply the water, which he would not filter.

ALTOONA, PA.—The council has voted to annul all action heretofore taken for an impounding reservoir at Kittanning Point, for which bids have been received three times, as stated last week.

DUSHORE, PA.—B. S. Collins, Boro. Secy., writes us that the Dushore Water Co., which was incorporated some time ago by residents of Scranton, will probably put in works in the spring.

ETNA, PA.—The council has completed negotiations for the purchase of the works for $85,000.

MEADVILLE, PA.—The council has directed the city solicitor to prepare an ordinance for the construction of works to be owned by the city.

PITTSBURG, PA.—The director of public works will recommend the purchase of three additional high-duty pumping engines, according to reports.

RIDLEY PARK, PA.—The citizens are reported as dissatisfied with the present service and talking of putting in works to be owned by the city.

SOMERSET, PA.—Bids are asked until Jan. 6 for works, including a reservoir. Wm. H. Welfley, Burgess.

BERKELEY SPRINGS, W. VA.—Bonds for $10,000 for works and electric lights have been voted.

MOUNDSVILLE, W. VA.—The Moundsville Water-Works Co. has been incorporated by J. T. Fawcett, Thos. Fawcett, W. H. Watt, Pittsburg; Benj. Wilson, Clarksburg; capital stock, $150,000 A 40-year franchise has been granted to the company, as stated last week.

CYNTHIANA, KY.—L. S. Williams, Cy. Clk., writes us that plans for works are expected to be presented to the council this week, at which time action will be taken for advertising for bids for the construction of the works. Engr., C. C. Breed, Louisville.

FRANKLIN, KY.—It is reported that the construction of the proposed works will be commenced early in the spring.

HOPKINSVILLE, KY.—The Hopkinsville Water, Light & Power Co. has secured the franchise granted to J. P. Martin and will put in works.

CADIZ, O.—Bids will be received until Jan. 2 for works, as stated in our advertising columns. W. H. Lucas, Tn. Clk.

NORWALK, O.—The citizens have voted to spend $4,000 for improving the works.

ST. BERNARD, O.—Henry Narre and H. J. Witte are members of a committee appointed to employ an engineer to prepare plans for works and an electric light plant.

BLOOMINGTON, IND.—Press reports state that the council has declared the franchise of the water company forfeited and ordered that the supply be turned out of the mains.

NORTH MANCHESTER, IND.—Joe Cowgill, Clk., writes us that the contract for the construction of works complete has been awarded to C. E. Coon & Co., Upper Sandusky, O.

JACKSON, MICH.—Plans are being prepared for proposed new boilers.

WOODLAND, MICH.—It is reported that the question of works is being discussed.

ARENZVILLE, ILL.—The citizens are figuring on works, according to reports.

AURORA, ILL.—The contract for an artesian well 1,500 ft. deep has been awarded to the Whitney Water Supply Co., St. Louis, at $2.18 per ft.

CENTRALIA, ILL.—Bids for proposed works referred to Nov. 30 will be received until Dec. 26. H. Van Cleve, Cy. Clk.

CHICAGO, ILL.—The Sonoma Water & Power Co. has been incorporated by E. P. Murdock, D. M. Carman and J. E. Moore; capital stock, $500,000.

WENONA, ILL.—The question of works is being discussed, according to reports.

GRISWOLD, IA.—The citizens have voted to issue bonds for $7.000 for works, and bids will soon be received for the construction.

PARKERSBURG, IA.—The citizens have voted to issue bonds for $6.000 for works.

EXCELSIOR, MINN.—The council is considering the question of works for fire protection.

MINNEAPOLIS, MINN.—Bids are asked until Dec. 21 for cast iron pipe, special castings, fire hydrants and water gates for the ensuing year. Chas. F. Haney, Cy. Clk.

HOT SPRINGS, ARK.—The Hot Springs Water Co. is about to make improvements and extensions estimated to cost $60,000.

SILOAM SPRINGS, ARK.—O. C. Macy, Cy. Clk., informs us that no arrangements have yet been made for works, but that steps will be taken in the future; population, 1,500.

SULPHUR SPRINGS, TEX.—A franchise has been granted to Maj. H. A. Evans and Jno. N. Polk, and bids are asked for the construction of the works and an electric light plant.

BOULDER, COLO.—The city council has voted to ask for bids for the proposed extensions, by each of two methods of construction: To tunnel for a distance of 2,000 ft. in bringing the water down from the new reservoir in Sunshine Canyon, piping the rest of the distance; and for an 18 to 12-in. pipe line the entire distance. H. E. Washburn, Cy. Clk.

MONTE VISTA, COLO.—It is reported that plans are being considered for works.

SPOKANE, WASH.—Contracts have been awarded as follows: Sections A, B and D, Hugh L. Cooper, at $229.459, $18,900 and $77,928 respectively; section C, Philip Buekner, $29.600. J. L. Martin bid $129.781 on section A and the itemized prices of the bid were published last week. Much indignation is reported on account of the award of this section.

TACOMA, WASH.—Jas. H. Morrison, Cy. Engr., is reported as stating that work on the proposed extensions will probably be commenced next month. There are 14 men engaged in arranging for the route of the mains.

ORANGEVILLE, ONT.—Plans have been prepared for a system estimated to cost $50,000 to $60,000, the supply to be from a well.

ARTESIAN WELLS.

MILLER, S. DAK.—Bids are asked until Dec. 22 for sinking a 3-in. artesian well. The contractor is to furnish everything and have the well completed by April 4. F. F. Beasom, Tn. Clk.; E. E. Furman, Chn. Com.

IRRIGATION.

NEW COMPANIES.—Nine-Mile Canal & Reservior Co., Bayard, Neb.; $10,000; E. M. Stearns, Thos. Roberts, Enos Adamson, J. O. Halleran and others.——White River Irrigation Co., Delano. Cal.: $200,000; T. W. Carr, S. J. Spangler, Orris; J. J. Schlitz, W. H. Smith, Alila; J. P. Stewart, Delano.

SEWERS.

MEDFORD, MASS.—T. Howard Barnes, Waltham, has been engaged to make plans for a system, and it is hoped to commence the construction in the spring. John D. Street, Chn. Com.

MILTON, MASS.—Plans for a system are being prepared by Geo. A. Kimball, Boston.

PLYMOUTH, MASS.—The town has voted to issue bonds for $15,000 for the proposed system.

PROVIDENCE, R. I.—The city treasurer will receive bids until Dec. 19 for $400,000 of gold bearing 4% sewer bonds.

HAMBURG, N. Y.—It is proposed to issue bonds for $30,000 or $40,000 for a system, according to reports.

JAMESTOWN, N. Y.—Bids will be opened about Jan. 1 for 67,000 ft. of 8 to 18-in. pipe sewers, average cut 12 ft.; estimated cost, $60,000. Wm. B. Landreth, Cy. Engr.

ROCHESTER, N. Y.—The lowest bid received last week for the University Ave. overflow for the East Side trunk sewer was that of Chambers & Casey, at $59.555. The lowest bid received last May for this work was over $4,000 above this price. It is now estimated that the cost of the entire sewer will not exceed $900,000. The appropriation was $1,000,000.

EASTON, PA.—Smith & McCormick have been awarded contracts for sewers in three streets, at $6,406.

KITTANNING, PA.—Arrangements are being made to issue the $30.000 of bonds recently noted as voted for a system. No surveys have yet been made. Dr. S. A. S. Jessop, Chn. Com.

LANCASTER, PA.—The contract for a 4-ft. brick sewer in Mulberry St. has been awarded to J. U. Fritchey, at $2.899, the work to be done this winter. Other bids were: Aukamp & Swartz, $4.220; B. E. Malone, $5.376; T. Wallace Reilly, $4,600; Isadore Pfeffer, $3,550; R. A. Malone, $6,975; J. G. Galbraith, $5,400.

LEBANON, PA.—The highway committee will receive bids until Dec. 28 for the Seventh St. sewer. T. R. Crowell, Engr.; J. H. Krause, Cy. Clk.

READING, PA.—The contract for sewers in the first district has been awarded to Wm. Grant Cook, New York, at about $176,000. The bids were published Nov. 30.——The city engineer has been authorized to advertise for bids for the erection of a sewage pumping station, to include a 5,000,000-gallon pumping engine.

BERKLEY, VA.—Chas. Bliven is reported as interested in a proposed system.

LEXINGTON, KY.—The council will engage an engineer to prepare plans for a complete system, according to reports.

BUCYRUS, O.—Bids are asked until Dec. 19 for constructing certain sewers. W. A. Blicke, Cy. Clk.

HAMILTON, O.—A petition has been prepared urging that the construction of a system be commenced at once. Robt. C McKinney, Secy Com.

BRIGHTWOOD, IND.—W. P. Messersmith, Tn. Clk., writes us that 1.500 ft. of egg-shaped brick sewer, 30 × 40 ins., is proposed, but that it has been decided to defer the construction until spring.

NEW ALBANY, IND.—The commercial club is agitating the question of a complete system of sewers. Geo. B. Cardwell and I. G. Strunk are members of the committee.

AURORA, ILL.—The following bids have been received for a brick sewer in Hazel Ave. and Sims St.: Rockford Construction Co., $30.868; Hallett & Anderson, $30.284: E. C. Mellon & Co., $28,253; Donaldson Bros., $23,456; Mall & Doan, $28,910.

CHAMPAIGN, ILL.—The combined system has been recommended, the approximate estimate being as follows: Outlet sewer, $16.000: three acres of filter beds, $9,000; 16 miles of collecting sewers, $64,000.

MADISON, WIS.—The council has authorized the purchase of land for the erection of sewage disposal works.

BOONE, IA.—Bids are asked until Jan. 3 for work to be completed by Jan. 1, 1896. Engr., Geo. E. Waring, Jr., Newport, R. I.; Jesse L. Hull, Cy. Clk.

ST LOUIS, MO.—Wm. Wise, Asst. Comr., informs us that contracts for the $90.000 worth of work recently referred to will probably be awarded in February.

SALT LAKE CITY, UTAH.—The mayor has vetoed the act of the council referred to last week.

OTTAWA, ONT.—An election will be held Jan. 1 to vote on an issue of bonds for $365,000 for the construction of the proposed trunk sewers.

STRATFORD, ONT.—Herbert J. Bowman, Berlin, has recommended that about 10 acres of land be secured for a sewage farm and that a main outfall sewer and two branch sewers be constructed; estimated cost, $30,000.

STREETS.

PROVIDENCE, R. I.—Bids are asked until Dec. 19 for $600,000 of 4% gold bonds, general account and highway loan. Frank M. Bates, Cy. Treas.

BUFFALO, N. Y.—The department of public works will receive bids until Dec. 28 for 10 contracts for paving with asphalt, Medina blocks and brick.

NEW YORK, N. Y.—The commissioner of public works will receive bids until Dec. 20 for five contracts for grading, setting curbs, etc.

BALTIMORE, MD.—The municipal street paving commission has selected Capt. G. J. Fiebiger, Washington, as advisory engineer. The commission will visit New York, Boston, Buffalo, Philadelphia and Washington and make a careful investigation of the question of street paving. Jas. Hodges, Chn. Comn.

LEXINGTON, KY.—The council has passed ordinances for paving five streets with brick, and plans are now being prepared for the work.

AVONDALE, O.—Bids are asked until Jan. 2 for $22,500 of 4% 30-year street improvement bonds. W. E. Wynne, Clk.

PLEASANT RIDGE, O.—Bids are asked until Jan. 6 for macadamizing, curbing and otherwise improving Cypress Ave. Engr., J. M. Harper, Ninth and Plum Sts., Cincinnati.

KANSAS CITY, MO.—It is reported that Grand Ave. will be repaved between Ninth and Twentieth Sts.

CONTRACT PRICES.

PUMPING ENGINES AND BOILERS.—Brockton, Mass.—Bids were opened Dec. 1 for furnishing, setting up and completing ready for use two pumping engines and two boilers, piping and all necessary appliances and fittings for the pumping plant for the city sewerage system. Each engine must be capable of easily raising 5.000,000 gallons of sewage per day 46 ft., through 16,650 ft. of 24-in. cast iron pipe, and each boiler must be capable of supplying steam for one of the engines when discharging 5,000,000 gallons per day. We are informed by F. Herbert Snow, Cy. Engr., that the bids were as follows:

Bids for Pumping Plant for the Brockton, Mass., Sewerage System.

			Duty, gals 1=1,000,000.		Cyl. diam., ins.					Boilers.			
Bidder.	Type of Engine.	Price.	Eng. and Boil.	Eng.	Steam.	Water.	St'ke, ins.	Piston speed, ft. per min.	St. pres. lbs.	Dia., ins.	Lth., ft.	Tubes. No.	Tubes. Dia., ins.
Holly Mfg. Co.	Comp. fly-wheel	$32,940	95	90	16 & 28	19	24			54	12	44	3¾
Snow Pump Wks.	" "	25.160	80	100	15 & 30	18	18	140	125	66	16		
" " "	Direct-act. comp.	16.220	48	60	12 & 20	23	18	85	80	66	16		
Groshon P'mp. Eng. Co	Comp. fly-wheel	21,500	95	105	14 & 26	17½	18*	150†	100	66	16	98	3
M. T. Davidson	Compound	29,500	58	62				90					
"	Triple expansion.	32,500											
Knowles Pump Co.	Trip. exp. fly-wh'l.	36,021	100	105	13 & 20 & 33½	15	24	195	125	54	18⅛	52	3½
" " "	Comp.-diff. plung.	21,000	50	55	14 & 28	19‡	24	100	80	66	2 ⅓	72	3½
" " "	Comp. fly-wheel	27,594	90	95	18½ & 33⅓	19	24	120	100	54	18⅛	52	3½
" " "	Triple expansion.	19.386	65	70	9½ & 15½ & 24	21	24	100	100	60	17	64	3½
" " "	Compound	18,941	50	55	12 & 24	21	24	100	80	66	20⅓	72	3½
Deane Pump Co.	Direct-act. comp.	17,540	45-50	45-50	12 & 24	22	24	90	75	54	18	60	3
" " "	Triple expansion.	18,280	50 55	55	7¾ & 12⅛ & 22	22	24	90	135	48	16	49	3
H. R. Worthington	" "	18 825	70	75	9 & 14 & 22	21	18			54	15		
"	Compound	15,900	47	52	12 & 22	21	18			60	16		

* Water, 18; steam, 36. † Water, 150; steam, 300. ‡ Discharge, 19; suction, 30

LEVEE WORK.—New Orleans, La.—The Lake Borgne levee board has awarded contracts as follows: F. C. Meevers, Martin levee, at 12.48 cts. per cu. yd.; Dr. N. M. Hebert, Bohemian levee, at 13.5 cts.

Memphis, Tenn.—A contract to close the Auburn crevasses or levee break in Desha county, Ark., about 80,000 cu. yds. of work, has been awarded to J. B. Lewis, Memphis, at a fraction under 10 cts. per cu. yd.

ELECTRIC LIGHT AND POWER.

BRADFORD, VT.—E. O. Leonard is interested in a proposed electric light plant at this place.

GREAT BARRINGTON, MASS.—It is reported that an electric light and power company has been organized with a capital stock of $100,000 to control the power at Glendale and extend the service to South Lee.

NEW YORK, N. Y.—The gas commission has received the following bids from electric light companies for furnishing arc lights during the ensuing year: Brush, 237 lamps at 40 cts. a night, 90 at 45 cts. and 48 at 50 cts.; United States, 382 lamps at 40 cts. and 23 at 50 cts.; Mount Morris, 339 lamps at 40 cts.; Harlem, 210 lamps at 40 cts. and 19 at 50 cts.; Manhattan, 150 lamps at 40 cts.; Edison, 105 double lamps in Fifth Ave. at 50 cts.; North River, 837 at 45 cts. No bids were received for certain streets and the work will be readvertised.

EASTON, PA.—The committee has decided to ask for $15,000 for the ensuing year, against $10,500 last year, for extensions and improvements.

ETNA, PA.—Plans have been made for an electric light plant, which will be constructed in the spring.

PHILADELPHIA, PA.—The department of public safety will receive bids until Dec. 20 for furnishing arc lights; also for a four-dial electro-mechanical fire alarm transmitter.

LOUISVILLE, KY.—The commercial club is considering plans for utilizing the water power of the falls of the Ohio River. Wm. A. Burr, Co. Engr., New Albany, Ind., has estimated that 12,000 E. HP. could be developed at a cost of $370,000 to $400,000. The following committee has been appointed to investigate the project: John T. and J. B. Gathright, Louisville; Herman Preefer and J. C. Zulauf, Jeffersonville, Ind.; Henry Goetz and Philip Helfrick, New Albany, Ind.; Wm. Reynolds and C. R. Thomas, Clarksville, Ind.

ST. BERNARD, O.—An engineer will be employed to make plans for an electric light plant and waterworks. Henry Narre, Mem. Com.

FLORENCE, COLO.—The Florence Electric Power & Light Co. is preparing to begin work on its plant, according to reports.

NEW COMPANIES.—Canonsburg Electric Light, Heat & Power Co.; Canonsburg, Pa.; $12,000; Treas., Chas. C. Johnson.——Thompson Electric Co., Wheeling, W. Va.; $25,000; C. H. Thompson and others, Martin's Ferry, O.; Alex. Hirth and R. Stalnaker, Wheeling.——Chicago Automatic Light Co., Chicago, Ill.; $10,000; Ed. S. Clarke, J. P. Hubbell, Maud M. Freeman.——General Mfg. Co., Bound Brook, N. J.; $2,500,000; A. W. Pollard, L. A. Pollard, Brooklyn; Jos. B. Cleaves, Bound Brook, and others.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

DREDGING.—Portland, Me.—Bids will be received at the U. S. Engineer Office until Dec. 29 for dredging in Back Cove, Portland Harbor. Lieut.-Col. Peter C. Haines, U. S. A.

LEVEE WORK.—New Orleans, La.—Bids will be received at the U. S. Engineer Office until Dec. 20 for 103,000 cu. yds. of work on the Forest Home levee, Lower Tensas district, 723 miles below Cairo. Capt. John Millis, U. S. A.

STEEL AND IRONWORK.—Toronto, Ont.—Bids will be received by Edmund Wragge, Union Station, Toronto, until Dec. 16 for the steel girder work, steel flooring and steel rolled beams for the Front St. and Bridge blocks of the new union station. Strickland & Symonds, Architects, 18 Toronto St.

GAS LIGHTING.—New York, N. Y.—The gas commission has received the following bids from gas companies for furnishing gas for street lighting during 1894: Consolidated, $17.50 per lamp, each light to burn 4,000 hours in the year; Equitable, $12; Standard, $13.04⅓; Central, $24; Northern, $28; Yonkers, $28; New York & New Jersey Globe (naphtha), $22. The Central, Northern and Yonkers companies are in the Annexed District.

DOCKS.—Buffalo, N. Y.—Press reports state that a syndicate of New York and English capitalists. represented by D. M. Thomas and James H. Mayo, of New York, has bought Squaw Island. in the Niagara River, near Black Rock, for $1,000,000. The buyers will erect 25,000 ft. of docks to cost about $1,500,000. Work will be begun in May and will occupy two years. Warehouses and elevators also will be built. and Buffalo's dock facilities will be increased 60% The capital of the company will be $5,000,000.

WATER TOWERS, ETC.—Philadelphia, Pa.—The department of public safety will receive bids until Dec. 20 for furnishing supplies during 1894. including Eureka fire hose, Woodhouse nozzles, hand fire extinguishers, one or more steam engines with pumps of 700 gallons capacity per minute, and one or more steam fire engines with pumps of 500 gallons capacity per minute, also for chemical engines, combined hose wagons and chemical engines, Duval water towers for aerial trucks, aerial extension ladders, water towers, etc.

INDUSTRIAL NOTES.

STEEL RAILS.—The Pennsylvania R. R. has made contracts with various companies for 43,000 tons of rails for 1894. Eastern mills get 36,000 tons at $24 and Western mills 7,000 tons at $25. Most of the orders are for 85-lb. rails, and no more 100-lb. rails are ordered. Last year the company contracted for 62,500 tons at $29 per ton, including 2,000 tons of 100-lb. rails.

THE LACLEDE CAR CO., St. Louis, Mo., has built the cars for the Third Ave. cable road in New York. They are 30 ft. long over all, with 22-ft. bodies, and are lighted by the Pintsch compressed gas system. The company is building 300 cable cars for the Philadelphia Traction Co. and 100 cable cars for the Broadway line of the Metropolitan Traction Co., New York.

THE MICHIGAN PENINSULAR CAR CO., of Detroit, Mich., has an order for 600 freight cars for the Chicago & Northwestern.

THE ANNISTON PIPE WORKS, Anniston, Ala., are reported as having been sold Dec. 5 to John B. Knox, for W. W. Stringfellow and W. S. Gurnee, Jr., representing the bondholders, and will be put in operation by them very soon. The property, which is probably the largest of the kind in the country, has been in the hands of receivers for three years.

MILLIKEN BROS., of New York, have been awarded the contract for the steel truss work to be used by the Ocean Grove Association, of Ocean Grove, N. J., in a new building. This building will be 210 ft. long and the roof has a clear span of 161 ft.

PURDY & HENDERSON, Chicago, have been engaged as consulting engineers to prepare working drawings for the superstructure and foundation plans for the Marquette Building, Chicago, and the Hennen Building, New Orleans.

THE INGERSOLL-SERGEANT DRILL CO.'S rock drill plant, which was exhibited at the Columbian Exposition, has been purchased by the Crown Reef Gold Mining Co., of Johannesburg, South African Republic. The company is the largest in that section, having an output of some 8,000 oz. per month.

THE YOUNGSTOWN BRIDGE CO., of Youngstown, O., is building a double track through plate girder bridge 82 ft. 8 ins. in length for the Cincinnati, Lebanon & Northern Ry., with a capacity for 123½-ton engines. Among other work under way are Z-bar columns for the seven-story Jackson Building, Nashville, Tenn.; two plate girder draws for the Jacksonville, St. Augustine & Indian River Ry., and three bridges for the Norfolk, Albemarle & Atlantic R. R.

FRASER & CHALMERS, Chicago, sole manufacturers of the Riedler pumping engines and air compressors in the United States, Mexico, England and Africa, are now putting these engines on the market for general use, and claim advantages in economy and duty.

FAIRBANKS, MORSE & CO., Chicago, have completed four wooden tanks for the new shops of the New York Central R. R. at Depew, N. Y. They are 16 ft. high, 24 ft. diameter, with a combined capacity of 200,000 gallons, and are placed on wooden trestles 50 ft. high. Two tanks, capacity 100,000 gallons each, have recently been completed for the Lancaster & Depew Water-Works Co., for use in connection with the water-works system at Depew, N. Y.